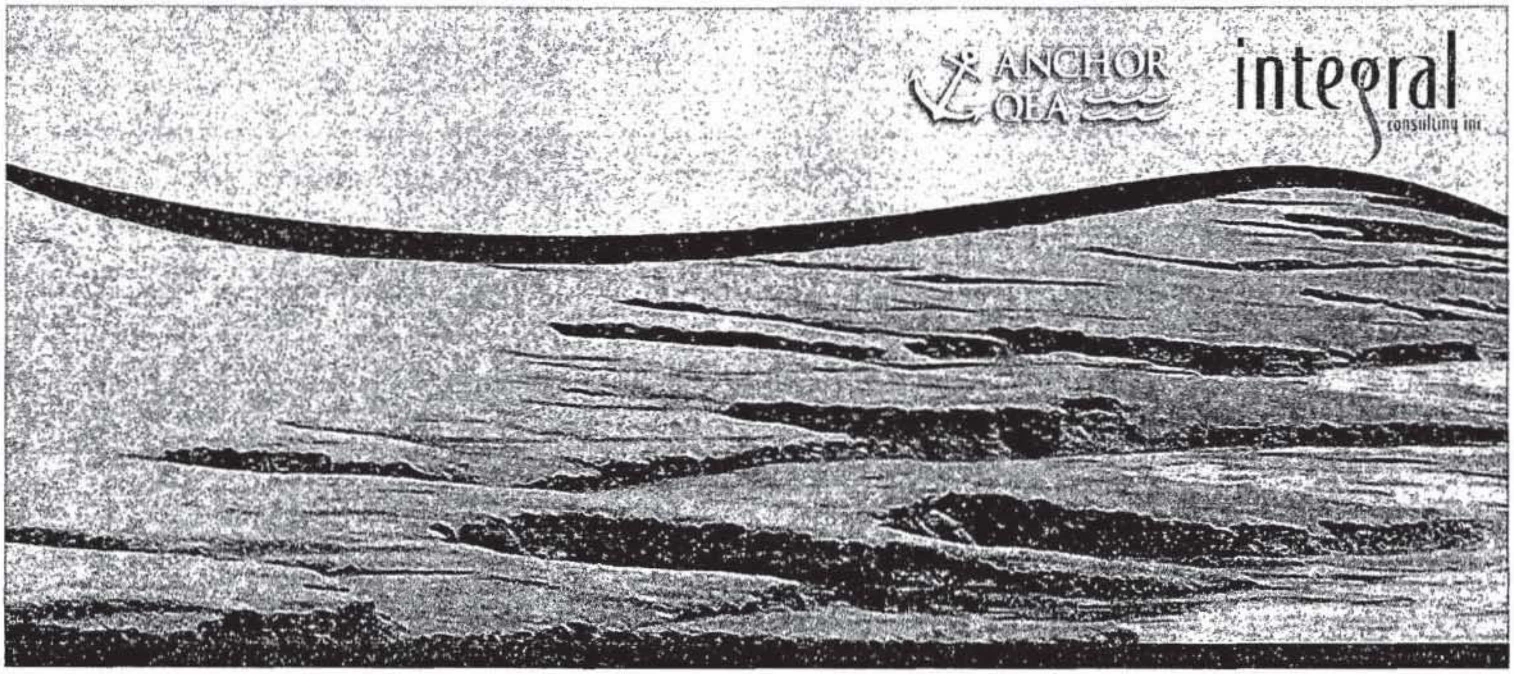

REVISED DRAFT GROUNDWATER STUDY SAMPLING AND ANALYSIS PLAN SAN JACINTO RIVER WASTE PITS SUPERFUND SITE

Prepared for

U.S. Environmental Protection Agency, Region 6

McGinnes Industrial Maintenance Corporation

International Paper Company

Prepared by

Anchor QEA, LLC
614 Magnolia Avenue
Ocean Springs, Mississippi 39564

Integral Consulting Inc.
411 First Avenue South, Suite 550
Seattle, Washington 98104

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November 2010

Title and Approval Sheet

Quality Assurance Project Plan Approvals

USEPA Remedial Project Manager:	Stephen Tzhone ____________	Date:	______
USEPA Quality Assurance (QA) Reviewer:	Walter Helmick ____________	Date:	______
Respondents' Project Coordinator and Anchor QEA Project Manager:	David Keith ____________	Date:	______
McGinnes Industrial Maintenance Corp. Project Manger:	Andrew Shafer ____________	Date:	______
International Paper Co. Project Manager:	Philip Slowiak ____________	Date:	______
Integral Project Manager:	Jennifer Sampson ____________	Date:	______
Laboratory QA Coordinator:	Craig Hutchings ____________	Date:	______
Chemical Laboratory Project Manager:	To Be Determined ____________	Date:	______
Chemical Laboratory QA Manager:	To Be Determined ____________	Date:	______

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LIST OF ACRONYMS AND ABBREVIATIONS

Anchor QEA	Anchor QEA, LLC
BERA	baseline ecological risk assessment
BHHRA	baseline human health risk assessment
CDD	chlorinated dibenzo-p-dioxins
CLP	Contract Laboratory Program
COC	chain-of-custody
COPC	contaminant of potential concern
COI	chemical of interest
CSM	conceptual site model
DGPS	differential global positioning system
DQO	data quality objectives
EDD	electronic data deliverable
EDL	estimated detection limit
FSP	Field Sampling Plan
GPS	global positioning system
GCAS	Gulf Coast Aquifer System
I-10	Interstate Highway 10
Integral	Integral Consulting
IPC	International Paper Company
IDW	investigation derived waste
MIMC	McGinnes Industrial Maintenance Corporation
MDL	method detection limit
MRL	method reporting limit
MSL	mean sea level
NPL	national priorities list
NOAA	National Oceanic and Atmospheric Administration
ORP	oxidation/reduction potential
PARCC	precision, accuracy, representativeness, completeness, comparability
PCB	polychlorinated biphenyl
PSCR	Preliminary Site Characterization Report

PVC	polyvinyl chloride
QA/QC	Quality assurance/Quality control
QAPP	Quality Assurance Project Plan
RI/FS	Remedial Investigation/Feasibility Study
ROD	record of decision
RPD	relative percent difference
SAP	Sampling Analysis Plan
SJRWP	San Jacinto River Waste Pits
SOP	standard operating procedure
SRM	standard reference material
SVOC	semivolatile organic compound
TAC	Texas Administrative Code
TAL	target analyte list
TCEQ	Texas Commission on Environmental Quality
TDSH	Texas State Department of Health
TOC	total organic carbon
TXDOT	Texas Department of Transportation
UAO	Unilateral Administrative Order
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound

1 PROJECT MANAGEMENT

1.1 Distribution List

Title	Name
USEPA Remedial Project Manager	Stephen Tzhone
USEPA QA Reviewer	Walter Helmick
Respondents' Project Coordinator and Anchor QEA Project Manager	David Keith
McGinnes Industrial Maintenance Corp. Project Manager	Andrew Shafer
International Paper Co. Project Manager	Philip Slowiak
Integral Project Manager	Jennifer Sampson
Field Lead	Chris Torell
Laboratory QA Coordinator	Craig Hutchings
Database Administrator	Dreas Nielsen
Chemical Testing Laboratory Project Manager	To be determined
Chemical Testing Laboratory QA Manager	To be determined

1.2 Introduction and Task Organization

This Groundwater Study Sampling and Analysis Plan (Groundwater Study SAP) for the San Jacinto River Waste Pits (SJRWP) Superfund Site (the Site; Figure 1) was prepared on behalf of International Paper Company (IPC) and McGinnes Industrial Maintenance Corporation (MIMC) (collectively referred to as the Respondents).

The Respondents have submitted the Remedial Investigation/Feasibility Study (RI/FS) Work Plan (Anchor QEA and Integral 2010) in fulfillment of the 2009 Unilateral Administrative Order (2009 UAO). UAO, Docket No. 06-03-10 was issued by the U.S. Environmental Protection Agency (USEPA) to the Respondents on November 20, 2009, (USEPA 2009a). The UAO directs the Respondents to prepare an RI/FS Work Plan for the Site in Harris County, Texas. This Groundwater Study SAP was created to supplement the RI/FS Work Plan by describing the groundwater assessment activities to be undertaken in support of achieving the overall RI/FS goals. Attached to this Groundwater Study SAP are Appendix A – Field Sampling Plan (FSP) and Appendix B – Benchmark Survey Data.

The rationale, scope, and methods provided in this Groundwater Study SAP build upon previous documents such as the RI/FS Work Plan, Sediment Study SAP (Integral and Anchor QEA 2010a) and Soil Study SAP (Integral 2010). The Groundwater Study, Soil Study, and Sediment Study SAPs should be consulted in planning, execution, and reporting of the work described herein, because soil samples will be collected as part of the Groundwater Study, and quality assurance (QA) specifications for these soil collections are described in the Soil and Sediment Study SAPs (Integral 2010 and Integral and Anchor QEA 2010). Lastly, the work described in this Groundwater Study SAP will be performed in compliance with the project Health and Safety Plan (Anchor QEA 2009).

This section reviews the organizational structure for activities associated with the Groundwater Study, including project management and oversight, fieldwork, sample analysis, and data management. The organizational structure for this project is illustrated in Figure 2. Contact information for key personnel is provided in Section 1.3.

For consistency, this Groundwater Study SAP has been organized as previous SAPs and certain text has been duplicated from those documents, as the information from those documents applies equally to this work.

1.3 Project Organization

MIMC and IPC have retained Anchor QEA and Integral Consulting, Inc. to perform this Groundwater Study SAP. The primary contacts for each organization, including USEPA oversight, are provided in the following tables:

Title	Name	Contact Information
USEPA	Stephen Tzhone	U.S. Environmental Protection Agency Region 6 1445 Ross Avenue Dallas, TX 75202-2773 (214) 665-8409 tzhone.stephen@epa.gov

Title	Name	Contact Information
McGinnes Industrial Maintenance Corporation Project Manager	Andrew Shafer	McGinnes Industrial Maintenance Corp. 9590 Clay Road Houston, TX 77080 (713) 772-9100 Ext. 109 dshafer@wm.com
International Paper Company Project Manager	Philip Slowiak	International Paper Company 6400 Poplar Avenue Memphis, TN 38197-0001 (901) 419-3845 philip.slowiak@ipaper.com

The names and quality assurance (QA) responsibilities of key project personnel for Anchor QEA and Integral are provided below. These tables may be revised in a future addendum (described below, to be submitted on behalf of IPC), as appropriate.

SAP Personnel Quality Assurance Responsibilities

Title	Responsibility	Name	Contact Information
Project Coordinator	Coordination of project information and related communications on behalf of IPC and MIMC	David Keith	Anchor QEA, LLC 614 Magnolia Avenue Ocean Springs, MS 39564 (228) 818-9626 dkeith@anchorqea.com
Corporate Health and Safety Manager Anchor QEA	Oversight of health and safety program for field tasks associated with RI/FS	David Templeton	Anchor QEA, LLC 1423 Third Avenue Suite 300 Seattle, WA 98101 (206) 287-9130 dtempleton@anchorqea.com
Field Lead Anchor QEA	Field data collection and implementation of the Health and Safety Plan in the field	Chris Torell	Anchor QEA, LLC 290 Elwood Davis Road Liverpool, NY 13088 (315) 453 9009 ctorell@anchorqea.com
Project Database Administrator Integral	Database development and data management	Dreas Nielson	Integral Consulting Inc. 411 First Avenue South Suite 550 Seattle, WA 98104 (206) 957-0351 dnielson@integral-corp.com

Title	Responsibility	Name	Contact Information
Project Laboratory QA Coordinator Integral	Completeness of QA documentation and procedures	Craig Hutchings	Integral Consulting Inc. 1205 West Bay Drive NW Olympia, WA 98502 (360) 705-3534 chutchings@integral-corp.com

The following responsibilities apply to the project manager and QA manager at the analytical laboratories, which are to be determined, for this task.

The laboratory project manager is responsible for the successful and timely completion of sample analyses, and for performing the following tasks:

- Ensure that samples are received and logged in correctly, that the correct methods and modifications are used, and that data are reported within specified turnaround times
- Review analytical data to ensure that procedures were followed as required in this Quality Assurance Project Plan (QAPP), the cited methods, and laboratory standard operating procedures (SOPs)
- Keep the task QA coordinator apprised of the schedule and status of sample analyses and data package preparation
- Notify the task QA coordinator if problems occur in sample receiving, analysis, or scheduling, or if control limits cannot be met
- Take appropriate corrective action as necessary
- Report data and supporting QA information as specified in this QAPP

The laboratory QA manager is responsible for overseeing the QA activities in the laboratory and ensuring the quality of the data for this project. Specific responsibilities include the following:

- Oversee and implement the laboratory's QA program
- Maintain QA records for each laboratory production unit
- Ensure that QA and quality control (QC) procedures are implemented as required for each method and provide oversight of QA/QC practices and procedures
- Review and address or approve nonconformity and corrective action reports

- Coordinate response to any QC issues that affect this project with the laboratory project manager

1.4 Problem Definition and Background

On March 19, 2008, USEPA added the Site to the National Priorities List (NPL), and the 2009 UAO requires that an RI/FS be conducted at the Site. The RI/FS will be undertaken to address the following objectives:

- Characterize the nature and extent of Site-related contamination
- Evaluate the physical characteristics of the Site and physical processes governing fate and transport of Site-related contaminants
- Perform a baseline human health risk assessment (BHHRA) and a baseline ecological risk assessment (BERA)
- If unacceptable risk is identified in the BHHRA or BERA, develop and evaluate potential remedial alternatives for the Site

A comprehensive description of the work to be performed, the methods to be used, and the schedule of activities that will address these objectives was presented in the RI/FS Work Plan, and are expanded upon in this Groundwater Study SAP (for groundwater-related activities). Once the RI/FS is complete, and if unacceptable risks exist, a remedy will be chosen, and following public comment, USEPA will document final selection of the remedy in a record of decision (ROD).

In late October 2010 (following initial submission of this draft Groundwater Study SAP for USEPA review), USEPA expressed concerns that historical uses of land to the south of I-10 may have resulted in contamination of soils in that area from the disposal of wastes, similar to those disposed of at the northern impoundments (Figure 1). The conceptual site model (CSM) and Site history presented in the RI/FS Work Plan do not address historical waste disposal in areas south of Interstate Highway 10 (I-10), or any related releases of hazardous substances, contaminant transport, or exposure pathways.

USEPA is requiring that the investigation include areas south of I-10 and IPC but not MIMC has agreed to perform the investigation in that area. MIMC's position is explained in a letter to USEPA from MIMC's legal counsel dated October 21, 2010. In response to USEPA's demand, and based on subsequent discussions, this revised Draft Groundwater Study SAP includes conceptual consideration of this southern impoundment. This consideration of the southern impoundment does not waive the legal position of MIMC as set out in the aforementioned October 21, 2010 letter. A more detailed historical description of the area south of I-10, a related CSM and, if warranted, a proposed groundwater sampling design will be presented on behalf of IPC in an addendum to this SAP (including an FSP addendum, as appropriate, to the sampling stations and methods that would be required), following a closer review of historical information for this area and verification of potential impacts. As such, unless specifically noted herein, information and discussions in this Groundwater Study SAP pertain to the impoundments located north of I-10. In particular, local geology and hydrogeology (discussed below) will need to be verified in the southern impoundment area, but are assumed at this time to be similar to area of the northern impoundments.

1.4.1 Site Description

The Site consists of impoundments, built in the mid-1960s for disposal of paper mill wastes, and the surrounding areas containing sediments and soils potentially contaminated with the waste materials that had been disposed of in these impoundments. Two impoundments, together approximately 14 acres in size, are located on a 20-acre parcel immediately north of the I-10 Bridge and on the western bank of the San Jacinto River, in Harris County, Texas (Figure 1).

USEPA has identified an area south of I-10 to be investigated, based on historical documents and aerial photographs indicating that an additional impoundment was constructed south of I-10, on the peninsula of land directly south of the 20 acre parcel, and also was used as a paper mill waste disposal area in the mid-1960s for paper mill waste similar to that disposed of in the two impoundments. A Texas State Department of Health (TSDH) inspection report dated May 6, 1966, indicates that this older impoundment contained a pond approximately 15 to 20 acres in size (TSDH 1966). Figure 1 shows both the known 1966 perimeter of the impoundments north of I-10 and the potential area of investigation of groundwater south of I-10. A discussion of the perimeter of the impoundment south of I-10 is presented below, and related uncertainties will be addressed in the Groundwater SAP Addendum to be submitted on behalf of IPC.

USEPA has not identified any evidence of releases or threatened releases of hazardous substances from the south impoundment. Sediment samples were taken in the Old River area south of I-10, adjacent to the south impoundment, as part of the April 2010 approved Sampling and Analysis Plan: Sediment Study San Jacinto River Waste Pits Superfund Site (Integral and Anchor QEA 2010). Results from the sediment sampling indicate that sediments from the three stations directly adjacent to the southern impoundment area are not contaminated with polychlorinated dibenzo-*p*-dioxins and polychlorinated furans (dioxins and furans) at levels greater than those found in sediment from the upstream background area sampled at the same time. In a fourth sample further downstream, 2,3,7,8-TCDD was not detected in sediment, and the toxicity equivalent (TEQ_{DF}) concentration was within the range of upstream background. These data suggest that dioxins and furans have not been released from the south impoundment to the adjacent aquatic environment. However, a number of uncertainties remain and will be addressed by groundwater sampling in the vicinity of the southern impoundments to be performed pursuant to the Groundwater SAP Addendum to be submitted on behalf of IPC.

1.4.1.1 Impoundment Construction

The northern impoundments are approximately 14 acres in size, built in the mid-1960s for disposal of paper mill wastes, and the surrounding areas containing sediments and soils potentially contaminated with the waste materials that had been disposed of in the impoundments. The northern set of impoundments is located on a partially submerged 20-acre parcel of real estate on the western bank of the San Jacinto River, in Harris County, Texas, immediately north of the Interstate Highway 10 (I-10) Bridge over the San Jacinto River (Figure 1).

In 1965, the northern impoundments were constructed by forming berms within the estuarine marsh, to the west of the main river channel. These impoundments at the Site were divided by a central berm running lengthwise (north to south) through the middle, and were connected with a drain line to allow flow of excess water (including rain water) from the impoundment located to the west of the central berm, into the impoundment located to the east of the central berm (Figure 1). The excess water collected in the impoundment located to the east of the central berm was pumped back into barges and taken off-Site.

Additional details about the construction and operation of the impoundment south of I-10 will be described in the Soil SAP Addendum to be submitted on behalf of IPC. However, some information is currently available to describe the spatial extent of possible impacts of the waste disposal activities that occurred south of I-10. As discussed above, two potential impoundment perimeters have been identified by USEPA. The larger of these perimeters, based on TSDH information, has been presented on Figure 1.

1.4.1.2 *Waste Disposal and Waste Characteristics*

In 1965 and 1966, pulp and paper mill wastes (both solid and liquid) were reportedly transported by barge from the Champion Paper Inc. paper mill in Pasadena, Texas and unloaded at the Site into the impoundments where the waste was stabilized and disposed. The excess water from these impoundments was pumped back into barges and taken off-Site. The Champion Paper mill used chlorine as a bleaching agent, and the wastes that were deposited in the impoundments have recently been found to be contaminated with polychlorinated dibenzo-p-dioxins, polychlorinated furans (dioxins and furans), and some metals (TCEQ and USEPA 2006); additional discussion of the chemical constituents typical of materials like those deposited in the impoundments is provided in Section 1.5 of the Sediment SAP (Integral and Anchor QEA 2010). The impoundments were used for waste disposal from September 1965 until May 1966, until both impoundments were filled to capacity. Since the eastern impoundment north of I-10 was used to dewater the western impoundment north of I-10 (as noted above), the capacity of the eastern impoundment for waste disposal is thought to have been less than that of the western impoundment.

The lateral and vertical extent of any solid wastes remaining in the area, or of soils contaminated by liquid wastes, will be addressed by soil sampling to be described in the Soil SAP Addendum to be submitted on behalf of IPC. Impacts to groundwater, if any, will be addressed by the Groundwater Study SAP addendum to be submitted on behalf of IPC.

1.4.1.3 Changes Over Time

Physical changes at the Site in the 1970s and 1980s, including regional subsidence of land in the area due to large scale groundwater extraction and sand mining within the river and marsh to the west of the impoundments, have resulted in partial submergence of the impoundments north of I-10 and exposure of the contents of these impoundments to surface waters. Historical aerial photography does not indicate that any part of the land south of I-10, or any southern impoundment, has been submerged as a result of subsidence.
Based upon review of U.S. Army Corps of Engineers (USACE) approved dredging permits, dredging by third parties has occurred in the vicinity of the perimeter berm at the northwest corner of the northern impoundments. Recent samples of sediment in nearby waters north and west of the northern impoundments (University of Houston and Parsons 2006) indicate that dioxins and furans are present in nearby sediments at levels higher than levels in background areas nationally (USEPA 2002a).

1.4.1.4 Surrounding Land Uses

As discussed in the RI/FS Work Plan, freshwater, estuarine, and marine habitats occur in the vicinity of the Site (Anchor QEA and Integral 2010). Residential, commercial, industrial, and other land use activities occur within the preliminary Site perimeter and in the surrounding area. Residential development on the eastern bank of the river is present within 0.5 mile of the Site. The northern impoundments are currently occupied by estuarine riparian vegetation to the west of the central berm, and are consistently submerged even at low tide to the east of the central berm. Estuarine riparian vegetation lines the upland area that runs parallel to I-10 and the uplands west of the northern impoundments. The area south of I-10, in which the southern impoundment was constructed, is currently under industrial or business uses including use by a towing company, a shipbuilding company, and a shipyard. Additional Site uses may have existed in the past, and will be assessed as part of the SAP addenda to be submitted on behalf of IPC. A sandy intertidal zone is present along the shoreline throughout much of the Site (Figure 1).

1.4.1.5 Local Geology

In the Site area, the surface and underlying local soils include Holocene alluvial deposits and the Beaumont Formation, which is the youngest and uppermost of the series of coast-parallel

Pleistocene deposits that make up the Gulf Coast Aquifer System (GCAS). The soils of the Beaumont Formation are dominated by clays and silts that were deposited in a fluvial-deltaic environment and that thicken seaward (Van Siclen 1991). The Beaumont Formation and overlying recent alluvial soils make up the uppermost units of the Chicot Aquifer (USGS 2002) which is discussed along with the Evangeline Aquifer in section 1.4.1.3 below. Figure 3 shows a fence diagram of former impoundment berm soils and river sediments in the vicinity of the waste impoundments, based on recent geotechnical borings completed at the Site and four borings completed previously by the Texas Department of Transportation (TXDOT). The soil borings confirm the presence of berm soils and recent alluvial sediments (interbedded clays, silts and sands), underlain by approximately 10 to 20 feet of Beaumont Formation clay. Additional discussion of the regional and local hydrogeology follows.

1.4.1.6 Regional Hydrogeology

The GCAS is located along the coast of the Gulf of Mexico and has been divided into four units; the Chicot and Evangeline Aquifers, Burkeville confining unit, and Jasper Aquifer. Each of these hydrogeologic units has particular hydrogeologic properties. The Site, located in Harris County, is above the Chicot and Evangeline Aquifers as shown in Figure 4. The Evangeline Aquifer is the deeper aquifer and it consists of the Goliad Sand Formation, which overlies the Burkeville confining unit of the Fleming Formation (not shown). The Burkeville unit is considered the basal unit within the Houston area and is a "no-flow" unit that separates the two above-mentioned aquifers from the more dense saline waters below. The base of the Evangeline Aquifer ranges from 5,000 feet below mean sea level (MSL) south of the coastline to slightly more than 200 feet above MSL at its northern, up-dip extent. The aquifer extends as far north as Washington County, Walker County, and surrounding counties and is thinnest in the up-dip direction. The Evangeline Aquifer has shallow water table conditions in these locations and becomes confined when moving southward through the Houston area toward the coast (USGS 2002).

The near-surface stratigraphy at the Site, as described above, makes up the uppermost units of the Chicot Aquifer. In stratigraphic order from youngest to oldest, the Chicot Aquifer consists of the Holocene surficial river alluvium underlain by the Beaumont, Montgomery, and Bentley Formations, and Willis Sand Formations (USGS 2002). The formations within the Chicot Aquifer are shown on the inset table on Figure 5, along with the surficial geology and locations of nearby groundwater wells (discussed below). Similar to the Evangeline Aquifer, the Chicot Aquifer extends from the coastline to the north of Houston into Austin, Waller, Polk, and surrounding counties, but not as far north as the Evangeline Aquifer (Figure 4). The base of the Chicot Aquifer is located more than 1,500 feet below MSL near the coast, to more than 100 feet above MSL near the upland limit of the aquifer. Like the Evangeline, the Chicot Aquifer has shallow water table conditions in upland locations and becomes confined by the Beaumont Formation clays and silts moving south through the Houston area toward the coast (USGS 1997).

Groundwater elevation maps for the Evangeline and Chicot Aquifers show that regional groundwater flow is directed down dip (i.e., approximately southeast) towards the Gulf of Mexico (USGS 2002). On a net flow basis, shallow groundwater discharges to the river and provides some of the river baseflow. Under high tide and river flow conditions, it is expected that a temporary gradient reversal will exist which causes rivers water to temporarily recharge the shallow alluvium adjacent to the river. Recharge to the Chicot Aquifer primarily occurs in the northern up-dip outcrop areas shown in Figure 6 where the Beaumont Formation is thinner or nonexistent. This area of recharge for the Chicot Aquifer is well up-gradient from the Site. As described later in this report, the fine-grained Beaumont Formation clays and silts separate the shallow alluvium from the underlying formations of the Chicot Aquifer and greatly restrict any recharge that might occur from alluvium to the Chicot Formations underlying the Beaumont (USGS 1997).

The Chicot Aquifer is used as a drinking water source within the greater Houston area, but water used for this source is pumped from wells screened much lower in the aquifer (i.e., below the Beaumont Formation). Although there are some upper Chicot Aquifer wells, privately owned, near the Site (see below), infiltration of surface waters or shallow groundwater into the lower units of the Chicot Aquifer would likely be prevented by the thick sequence of the clay and silt deposits of the Beaumont Formation, effectively isolating the lower portion of the Chicot Aquifer from shallower groundwater and surface water in the Site vicinity (USGS 2002).

1.4.1.7 Local Hydrogeology

The local water table (i.e., shallow groundwater) is found near land surface in the shallow alluvium sediments, generally at the approximate elevation of the San Jacinto River water surface. Groundwater movement in the shallow alluvium in the Site area is likely dominated by surface water/groundwater interactions with the river, which surrounds the former impoundments. In regions such as the Site area (i.e., shallow water table, relatively flat topography), shallow groundwater typically discharges to surface water bodies (Fetter 1994; Freeze and Cherry 1979). This reach of the San Jacinto River watershed is an area of minimal recharge to aquifers and would therefore likely have flat groundwater gradients (see Figure 6; USGS 1997). The Beaumont Formation clays and silts under the Site isolate shallow groundwater in the Holocene alluvium and in the San Jacinto River sediments from the underlying formations of the Chicot Aquifer. This presence of the Beaumont Formation clays and silts underlying the alluvium are shown on the fence diagram in Figure 3.

There are three groundwater wells near the east bank of the San Jacinto River that are within approximately 3,000 feet of the impoundments (Figure 5, Table 1). The Harris County WCID 1 (#6516506) well penetrates the Lower Chicot Aquifer at a depth of 537 feet (elevation -497 feet MSL) and is approximately 1,000 feet due east of the former impoundments. A well owned by C. Fitzgerald (#6516812) penetrates the Upper Chicot Aquifer at a depth of 125 feet (elevation -95 MSL) and is approximately 1,900 feet southeast of the former impoundments. A well owned by Vahlco Corp. (#6516811) penetrates the Lower Chicot Aquifer at a depth of 530 feet (elevation -94 MSL) and is approximately 3,500 feet south of the former impoundments.

Given that these potable water wells are screened within or below the Beaumont Formation, it is expected that their water quality would be different than the shallow groundwater beneath the Site and potentially influenced by the San Jacinto River. Since this reach of the San Jacinto River is a tidal estuary, the river water has a very high natural salt content and total dissolved solids, which is likely to be reflected in shallow groundwater near the former impoundments.

Figures 7 and 8 depict water quality data from wells 6516811 and 6516812, collected in 1972 (TWDB 2010), screened in the Lower Chicot, and surface water monitoring data collected from the San Jacinto River in 2009 (HGAC 2010). Note, that these well completion data from 1972 are the only publicly available data for these wells. The data shown for the San Jacinto River are the averages for each parameter using data collected in 2009 from station 11193 (HGAC 2010); data for surface water in the river does not exist from 1972 when these wells were sampled. The data are presented on a Stiff diagram (Figure 7) and Piper diagram (Figure 8). These are commonly used graphical presentations for water quality data used to determine water source similarities and differences by comparing concentrations of common cations and anions.

The signature of the San Jacinto River water is markedly different than the two monitoring wells on both the Stiff diagram and Piper diagram, indicating two distinct water sources and that the Beaumont Formation effectively isolates the Chicot Aquifer from recharge from shallow groundwater in the Site vicinity. Because the depth of the channel of the San Jacinto River is deeper than the depth of the base of the impoundments, it can be assumed that the Beaumont Formation not only acts as an aquitard that keeps saline surface water from infiltrating into potable water supplies in the Chicot, but that the Beaumont also is an effective aquitard to saline shallow groundwater surrounding the Site.

Based on the local hydrogeology, water quality analysis and regional recharge considerations, it is unlikely that shallow groundwater in general, or any Site related contaminants of concern specifically would affect local wells. In order for shallow groundwater near the Site to affect local wells in the Chicot Aquifer, groundwater from the Site alluvial sediments would have to overcome significant surface water/groundwater interactive forces, penetrate up to approximately 20 feet of Beaumont Formation clay and silt, which has been shown to confine the Chicot Aquifer in the region by the USGS (2002), and flow under the San Jacinto River to reach these wells. Finally, the main chemicals of potential concern (COPCs), dioxins/furans, strongly adsorb to soil particles and have very low solubility and mobility in groundwater (Fan et al. 2006; USAF 2006; ATSDR 1998), further decreasing the likelihood of contaminant transport by groundwater from the Site to these distant wells. ATSDR (1998) indicates that chlorinated dibenzo-p-dioxins (CDDs) "…bind strongly to the soil, and therefore are not likely to contaminate groundwater…" and "CDDs are unlikely to leach to underlying groundwater…" Finally, no data are available to indicate that either these three wells or any other public water supply wells have been impacted or are threatened by Site related contaminants.

1.4.2 Summary of Available Data

No known groundwater data exists for the impoundments north of I-10 or the impoundment south of I-10. Available soils data for the Site is described in the Soil Study SAP (Integral 2010). The RI/FS Work Plan (Anchor QEA and Integral 2010) summarizes regional groundwater data.

1.4.3 Problem Definition

Because there is no Site-specific information on the occurrence or chemical characteristics of shallow or deeper groundwater under either the northern impoundments or southern impoundment, there is unacceptable uncertainty about the condition of groundwater beneath the Site and whether groundwater quality is affected by the Site. Additional information is required to describe the nature and extent of Site-related COPCs in local groundwater, processes governing the fate and transport of Site-related COPCs to groundwater, and overall hydrogeologic processes at the Site. This information is required to address data gaps for northern impoundments groundwater that are identified in the RI/FS Work Plan. Data gaps related to the potential southern impoundment will be further assessed and discussed in the Groundwater Study SAP addendum to be submitted on behalf of IPC.

1.5 Chemicals of Potential Concern

This section discusses the selection of groundwater analytes. However, there are different uncertainties for groundwater north of I-10 than for groundwater south of I-10. Therefore, the process for identification of COPCs for groundwater differs between the two areas.

The Sediment SAP (Integral and Anchor QEA 2010) describes the process and rationale for selection of primary COPCs and secondary COPCs for media that may have been contaminated by wastes deposited in the northern impoundments, and how their analyses relate to those for the indicator chemical group, dioxins and furans (this discussion is also provided as Appendix C to the RI/FS Work Plan; Anchor QEA and Integral 2010). To identify analytes for groundwater samples collected according to this SAP, analyses of sediment data is required, as follows. Results of sediment chemical analyses from the sediment sampling conducted in May 2010 will be generated prior to the performance of Groundwater Study sampling. Using validated chemistry data for sediments, results for secondary COPCs will be evaluated for 1) frequency of detection in sediments, 2) against risk based screens, and 3) for statistical correlation with dioxins and furans in sediment that are representative of the wastes in the impoundments (i.e., one or more of the most common congeners in waste-related sediments). This type of evaluation has been cited in other SJRWP SAPs to provide a means to select analytes for sampled media.

However, considerations for groundwater are different because the risk based screens address receptor exposures due to direct contact and bioaccumulation, whereas Groundwater Study sampling will be conducted to address agency concerns (expressed in June 3, 2010, comments on the Draft RI/FS Work Plan) about the quality of water in wells that occur within 3,000 feet of the Site (USEPA comments 12 and 13), and transport to groundwater (USEPA comment 22).

COPCs for groundwater from the northern impoundments will be determined according to the following bullets[1]:

- Primary COPCs will be analyzed in all Groundwater Study samples.
- Secondary COPCs that are detected in 5 percent or fewer sediment samples will not be analyzed in groundwater.
- Volatile organic compounds (VOCs) that are considered secondary COPCs in the Sediment SAP will not be analyzed in groundwater. This is consistent with a determination during sediment sampling (in May, 2010) that, because VOCs were never detected in a representative subsample of surface and subsurface sediments (including within the waste impoundments), or were estimated to be present at only very low levels, that additional analyses in other sediment samples were not needed

[1] Because, according to USEPA, the materials deposited in the impoundment south of I-10 are believed to be of the same origin and types as those deposited in the northern impoundments, groundwater analytes for potential samples collected south of I-10 were determined in the same manner as the analytes for groundwater in the northern impoundments (i.e., through the analysis and considerations detailed in Appendix C to the RI/FS Work Plan (Anchor QEA and Integral 2010), and in Section 1.5 of the approved Sediment SAP (Integral and Anchor QEA 2010).

(Tzhone, S. personal communication with D. Keith and J. Sampson, May 28, 2010). Because VOCs were generally not present in surface and subsurface sediments within the waste impoundments, the waste impoundments are not considered to be a potential source of VOCs to groundwater.

In summary, the initial northern impoundments groundwater analytes for this study are the primary COPCs for sediments (Table 2). VOCs will not be analyzed in groundwater from the northern impoundments. Other secondary COPCs will be analyzed in northern impoundment groundwater samples if they are detected in more than 5 percent of sediment samples, consistent with decisions rules above.

COPCs for groundwater from the southern impoundment consider the lack of soil data from this area and will be determined according to the following bullets:

- For groundwater to be collected south of I-10, initial analytes will include all of the chemicals of interest (COIs) identified in the Sediment SAP (Integral and Anchor QEA 2010) and listed in Table 5 of that document, modified to include all of USEPA's target analyte list (TAL) metals. COIs represent those chemicals that are:
    - On the target analyte list for metals, the priority pollutant list for surface water and on the contract laboratory program analyte list,
        - and are potentially associated with pulp mill solid wastes or effluents,
        - and are persistent in the environment,
    - or were detected at least once in samples collected by TCEQ and USEPA (2006) (see Section 1.5 of the Sediment SAP)

There are no pre-existing samples for soils or groundwater in the southern impoundment that allow performance of a risk based screen. Given that the origin and types of the waste are believed to be the same as for the material deposited in the impoundments north of I-10, this approach for identifying southern impoundment groundwater COPCs relies on the same logic as described in Section 1.5 of the Sediment SAP. It is conservative in including all chemicals that were considered prior to the screening step, and all TAL metals that were eliminated on the basis of an evaluation of waste characteristics. Further discussion and presentation of southern impoundment groundwater COPCs will occur in the Groundwater Study SAP addendum to be submitted on behalf of IPC.

For completeness, this SAP describes analytical methods, mass requirements, holding requirements and other QA/QC procedures for all primary and secondary COPCs (other than VOCs), so that secondary COPCs can be effectively analyzed in groundwater if necessary, as appropriate to the findings of the Sediment Study. The process outlined above for selecting COPCs, and related decisions, will be further described in a COPC Technical Memorandum anticipated to be completed in fall 2010.

In addition to the analysis of COPCs, certain conventional analytes will be assessed in groundwater during well development, purging, and sampling. Please see Sections 2.2.5 and 2.2.6 and Attachment A-1 to the FSP for the rationale, scope, and frequency of collection of conventional groundwater data.

1.6 Uncertainties and Data Gaps – Nature and Extent

As outlined in the RI/FS Work Plan, data gaps exist in the nature and extent component of Site characterization for groundwater. Groundwater data does not exist for either the northern or southern impoundments. More specifically, these groundwater data gaps are:

- Information regarding the potential presence and extent of COPCs in groundwater
- Characterization of groundwater flow gradients
- Information regarding the hydrologic interaction between groundwater and surface water
- General groundwater characterization data (i.e., non-COPC chemistry and physical properties data)

These data gaps have been identified for the northern impoundments and likely exist, at a minimum, for the potential southern impoundment. The data gaps for the northern impoundments will be addressed by the tasks described in this SAP. The Groundwater Study SAP addendum to be submitted on behalf of IPC will discuss data gaps for the potential southern impoundment.

1.7 Task Description

The work described in this Groundwater Study SAP will be conducted to fill the groundwater data gaps identified in the RI/FS Work Plan, to assist in definition of the CSM, and support the FS. Specifically, the primary objectives of the work presented in this Groundwater Study SAP are:

- Obtain groundwater chemistry data from the Site
- Assess the potential for Site-related constituents to be transported by groundwater
- Characterize groundwater flow, including horizontal and vertical gradients within the alluvial and upper Beaumont Formation sediments

Secondary objectives include:

- Obtain hydrologic data describing potential groundwater/surface water interactions
- Further characterize and verify Site subsurface conditions, including the presence and thickness of the Beaumont clay unit
- Obtain additional soil data (see Soil Study SAP [Integral 2010] for additional soil investigation information)

1.8 Data Quality Objectives

1.8.1 Soil

The soil data quality objectives (DQOs), soil sampling scope and handling/analytical methods are discussed in detail in the Soil Study SAP (Integral 2010). The FSP of this Groundwater Study SAP provides procedures to obtain the soil samples using the direct push drilling rig.

1.8.2 Groundwater

1.8.2.1 Statement of the Problem

Groundwater data has not been collected at the Site, resulting in data gaps with regard to the CSM. Specifically, the impact, if any, to Site groundwater by COPCs is unknown. Additionally, subsurface soils and groundwater quality/flow gradients have not been characterized at the Site.

As will be discussed in detail in the Groundwater Study SAP addendum to be submitted on behalf of IPC, the statement of the problem for the southern impoundment is anticipated to be similar. If pending assessments of the southern impoundment confirm similar historical uses and CSM as the northern impoundments, it is anticipated that the sampling design and analytical approach for the southern impoundment would be similar, at a minimum, to the same described for the northern impoundments provided below.

1.8.2.2 Sample Collection Design

Groundwater data will be collected to characterize both general groundwater quality as well as the potential presence of COPCs in groundwater at the Site. Representative groundwater samples will be collected for COPC analyses using SW-846 methods (USEPA 2009b). Also, during well development, purging and sampling, conventional groundwater parameter data (turbidity, dissolved oxygen, specific conductance, temperature, pH, and oxidation/reduction potential) will be obtained.

Prior to sampling, wells will be developed in accordance with ASTM D5521 *Standard Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers* to mitigate effects of drilling operations on *in-situ* formations and with the goal of collecting representative groundwater data and samples. After development activities, each well pair will be purged and sampled for COPCs (see Section 1.5), in accordance with the TCEQ memorandum dated July 31, 2003, *Sample Handling and Preservation Procedures and the Collection Procedures for Groundwater Samples,* the January 5, 1998, TCEQ standard operating procedure *Groundwater Sampling – Filtering, Low Flow Purging,* and USEPA's *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples From Monitoring Wells* (USEPA 1996).

Groundwater analytical data will be validated consistent with the *Guidance on Environmental Data Verification and Validation* (USEPA 2002b) and according to methods described in USEPA's *National Functional Guidelines* for inorganic, organic, and dioxin data review (see Section 4; USEPA 2004, 2005a, 2008).

Soil sample collection design is discussed in the Soil Study SAP (Integral 2010).

1.8.2.3 Analytic Approach

The work described in this SAP is being conducted to further define the CSM. Groundwater Study samples will be collected to determine if COPCs are present in groundwater in alluvial sediments (i.e., shallow groundwater) and sediments below the Beaumont Formation clay (i.e., deep groundwater) under the Site. Conventional groundwater parameters and water level data will be collected to assess general groundwater quality and behavior (i.e., flow gradients). Soil samples will be collected to characterize subsurface stratigraphy and support assessments of COPCs in soil (see Soil Study SAP; Integral 2010).

Results of groundwater analyses will be compared with TCEQ PCLs and National Drinking Water Standards. If results are below standards, no additional groundwater work is anticipated. If results exceed standards, additional evaluations may be conducted in an effort to determine the source of COPCs exceeding standards. These may consist of:

- Assessment of background water quality. This assessment would include identifying an appropriate location for data collection that is unimpacted by contamination and collection of groundwater from waterbearing unit(s) in hydraulic communication with those in which the Site wells are screened. If background groundwater sampling is needed, the location of the background groundwater sampling would be demonstrated to be definitively upgradient of the Site.
- Additional investigation and/or sampling with regard to nature and extent of COPCs in Site groundwater.
- Investigation of fate and transport of COPCs potentially in Site soils to groundwater.
- Assessment of the relative groundwater characteristics and quality between the alluvial sediments and the upper Chicot under the Site.
- Assessment of the subsurface lithology at the Site and its relationship with an effect on COPC distribution in soils or groundwater.

1.9 Special Training and Certification

A technical team will be assembled with the requisite experience and technical skills to successfully complete the work described in this Groundwater Study SAP and the subsequent addendum submitted on behalf of IPC. Personnel on Site will comply with the requirements of the Site Health and Safety Plan (Anchor QEA 2009).

Selected laboratories will hold certification through the National Environmental Laboratory Accreditation Program for the methods which that laboratory will perform, where applicable. Training and certification requirements for laboratory personnel will be provided in the laboratory QA plan(s).

1.10 Documents and Records

Records will be maintained documenting activities and data related to sample collection and to laboratory analyses for work at the northern impoundments and southern impoundment. Results of data verification and validation activities will also be documented. Procedures for documentation of these activities are described in this section.

The QAPP and FSP (Appendix A) will be provided to the task participants listed in Section 1.1. Any revisions or amendments to any of the documents that make up the FSP will also be provided to these individuals.

1.10.1 Field Records

Components of relevant field documentation are discussed in Section 3 of the FSP. Field records that will be maintained include the following:

- Field logbooks
- Photo documentation
- Field data and sample collection information forms
- Field change request forms (as needed)
- Sample tracking/chain-of-custody (COC) forms

Observations recorded in the field logbook will be used to provide context and aid in presentation and interpretation of analytical results. Additional details regarding the content and use of these documents are described in Section 3.1 of the FSP.

1.10.2 Laboratory Data Reports

Activities and results related to sample analysis will be documented at each laboratory. Internal laboratory documentation procedures are described in the laboratory QA manuals.

Each laboratory will provide a data package for each sample delivery group or analysis batch that is comparable in content to a full Contract Laboratory Program (CLP) package. The format of the data may differ from CLP requirements. Each data package will contain information required for a complete QA review, including the following:

- A cover letter discussing analytical procedures and any difficulties that were encountered
- A case narrative referencing or describing the procedures used and discussing any analytical problems and deviations from SOPs and this QAPP
- COCs and cooler receipt forms
- A summary of analyte concentrations (to two significant figures, unless otherwise justified), method reporting limits (MRLs), and method detection limits (MDLs) or estimated detection limits (EDLs)
- Laboratory data qualifier codes appended to analyte concentrations, as appropriate, and a summary of code definitions
- Sample preparation, digestion, extraction, dilution, and cleanup logs
- Instrument tuning data
- Initial and continuing calibration data, including instrument printouts and quantification summaries, for all analytes
- Results for method and calibration blanks
- Results for all QA/QC checks, including but not limited to labeled compounds, surrogate spikes, internal standards, serial dilutions, laboratory control samples, matrix spike samples, matrix spike duplicate samples, and laboratory duplicate samples provided on summary forms
- Instrument data quantification reports for all analyses and samples
- Copies of all laboratory worksheets and standards preparation logs

Data will be delivered by the laboratories in both hard copy and electronic format to the task QA coordinator, who will be responsible for oversight of data verification, validation, and for archiving the final data and data quality reports in the project file. Electronic data deliverables (EDDs) will be compatible with the project database.

1.10.3 Data Quality Documentation

Data verification (i.e., confirming the accuracy and completeness of field and laboratory data) will be completed by the SJRWP technical team for data generated in the field, and by each laboratory for the data that it generates. Data validation reports for chemical analyses will be prepared as described in Section 4 and provided to the task QA coordinator. All changes to data stored in the database will be recorded in the database change log. Any data tables prepared from the database for data users will include all qualifiers that were applied by the laboratory and during data validation.

1.10.4 Reports and Deliverables

The laboratories will keep the laboratory QA coordinator informed of their progress on a weekly basis. The laboratories will provide the following information:

- Inventory and status of samples held at the laboratory in spreadsheet format by sample delivery group
- Summaries of out-of-control laboratory QC data and any corrective actions implemented
- Descriptions and justification for any significant changes in methodology or QA/QC procedures

Consistent with the 2009 UAO, the draft Preliminary Site Characterization Report (PSCR) will be submitted to USEPA after the completion of all laboratory and data validation work for all of the field studies that will be required for the RI/FS, and according to the schedule provided in Section 8 of the RI/FS Work Plan (Anchor QEA and Integral 2010). Prior to submittal of the draft PSCR, data will be made available online according to the schedule for each sampling program provided the RI/FS Work Plan schedule (Anchor QEA and Integral 2010). Interpretation of the data will be presented in the RI report.

It is anticipated that any work proposed and conducted for the southern impoundment will be completed in a timely manner to conform to the schedule for the PSCR described above. However, results of research into the southern impoundment history and CSM, and resultant investigatory work, may require a different reporting schedule than for the northern impoundments.

2 DATA GENERATION AND ACQUISTITION

2.1 Overall Approach

The overall approach of the work described in this Groundwater Study SAP is to install and monitor three well pairs through one round of sampling to obtain representative and reliable data regarding groundwater characteristics and behavior in both alluvial sediments and the upper Beaumont Formation, as described in detail, below. The proposed monitoring wells locations are shown on Figure 9. Data will be obtained using current and accepted investigation and evaluation techniques and methods. Given that groundwater data has not been collected from the Site, the investigation will be conducted to fulfill the objectives described in Section 1.7. The sampling design and sampling procedures are provided in this section.

The work described herein is based in part on current knowledge of the subsurface stratigraphy at the Site. Figure 3 depicts the cross section and cross section location originally provided in the RI/FS Work Plan, and includes the approximate locations of the proposed well pairs (discussed below) along the cross section. As shown on the cross section, the wells would be screened in the alluvium above and below the Beaumont.

The overall approach to be submitted by IPC for work in the southern impoundment is expected to be similar, provided similar Site history and CSM are determined. The particular study tasks and sampling design for the southern impoundment would be anticipated to be similar to those described below for the northern impoundments. Given that the southern impoundment appears larger in area, and has varied historical uses (based on preliminary review of historical aerial photography), compared to the northern impoundments, it is possible that differing and/or additional study tasks would be needed.

2.2 Study Tasks

This section provides a summary of the Groundwater Study tasks. Each task is discussed in detail in Section 2.3. Specific task methodologies are described in detail in the FSP (Appendix A).

- Borehole advancement at three paired locations (6 total borings; one boring completed in the alluvial sediments and one double cased boring completed below the Beaumont Formation in each pair)

- Soil sampling for grain size and total organic carbon (TOC) analyses, and for archiving for potential future analysis for chemicals of potential concern (COPC) at each boring pair from 0 to 5 feet below grade (1 composite sample) and on a 1 foot composite basis from 5 feet below grade to boring terminus on a 5 foot interval basis (samples from 9-10 feet, 14-15 feet, etc. below grade)
- Temporary monitoring well construction and installation in each boring
- Monitoring well development, purging and collection of Groundwater Study samples for COPCs (see Section 1.5)
- Hydrology data collection from newly installed monitoring wells and from an established stream gage on the San Jacinto River
- Data evaluation, synthesis and reporting (within the pending PSCR)
- Monitoring well abandonment immediately following sampling consistent with Texas guidance (State of Texas 2010a). Abandonment is required immediately following the initial round of sampling because of planned removal action construction activities.

2.3 Sampling Design and Methods

2.3.1 Location Positioning

2.3.1.1 Design

Location positioning consisting of latitude, longitude, and elevation data will be obtained to ascertain and document the position of sampling locations, well casings, ground surfaces, and other point locations as needed. Location positioning will be conducted to approximate the locations of planned activities (i.e., boring locations) and document completed activities (i.e., top of well casings). The groundwater investigation field crew will conduct pre-work positioning. A Texas-licensed professional surveyor will obtain post-work positioning data. Reported data will be referenced to NAD1983_StatePlane, Texas South Central, FIPS 4204, US feet.

2.3.1.2 Methods

For pre-work needs, a hand held global positioning system (GPS) will be used to identify the positions of all sampling locations to within ±2 m horizontal. Proposed sampling location coordinates are provided in Table 3. Figure 9 depicts the sampling locations in plan view.

Differential global positioning system (DGPS) may be used to document post-work positions and elevations if suitable accuracy can be verified. However, standard survey techniques may be required to obtain required accuracies of +/- 0.1 foot horizontal and +/- 0.01 foot vertical. All post-work survey activities will be conducted by a Texas-licensed professional surveyor using Texas Administrative Code (TAC) procedures (State of Texas 2010b), and relative to the Harris County Subsidence District benchmark HGCSD 33 (26.57 feet NAVD88 – TSARP) previously used at the Site.

2.3.2 Borehole Advancement and Soil Sampling

2.3.2.1 Design

Three pairs of boreholes (one "shallow" boring and one "deep" boring in each pair) will be advanced at locations within the Site to enable monitoring well pair installation, along with soil sampling and lithologic data collection (Figures 3 and 9). The shallow borings will be advanced to just above the top of the Beaumont Formation clay. The deep borings will be double cased in the Beaumont Formation clay to limit potential hydraulic connectivity between the alluvial sediments and the lithologic units below the Beaumont Formation clay. The deep borings will be terminated approximately 10-15 feet below the base of the Beaumont Formation clay. Figure 3 depicts two anticipated boring pair locations relative to the current understanding of Site lithology. Deep borings will be advanced first, allowing accurate placement of shallow borings with regard to the Beaumont Formation clay. Soil sampling will only be conducted at the deep boring for each well pair. The soil log for the deep boring will also be used to plan the well construction for the shallow well at each location.

Soil samples will be collected at each well pair for lithologic logging and, grain size, TOC, and potential COPC analyses (see Soil Study SAP). It is anticipated that sampled units will not be duplicated within borehole pairs or relative to nearby borings. In the unlikely, but potential, need of borehole abandonment precluding well installation, boreholes will be pressure grouted from depth to ground surface.

2.3.2.2 Methods

Soil borings will be advanced in accordance with standard direct push procedures and *Groundwater Sampling and Monitoring with Direct Push Technologies* (USEPA 2005b) and ASTM references therein. Due to potential access difficulties at the Site, an all terrain type of drilling machine may be required at the Site. Prior to drilling the ground conditions will be assessed by the drilling contractor to determine the type of equipment needed. Drill tooling (casing, rods, etc.) is anticipated to be 3.5 inch nominal inside diameter and will be selected considering eventual casing and well construction requirements as well as anticipated subsurface conditions.

For deep borings that will penetrate the Beaumont clay (one boring at each pair), an outer, 4.5 inch nominal outside diameter double casing will be set approximately 5 feet into the clay, as described above, to prevent downward migration of groundwater through the Beaumont clay.

Soil samples will be collected continuously for logging purposes to total depth at each deep borehole. Soil samples will be collected for grain size, TOC, and COPC analyses from 0 to 5 feet below grade (composite over full interval) and over 1 foot intervals every 5 feet thereafter (9 to 10 feet, 14 to 15 feet, etc.). The Soil Study SAP (Integral 2010) provides additional details of soil sampling in borings. Appendix A - FSP of this Groundwater Study SAP further describes the drilling methods to obtain soil samples.

2.3.3 Monitoring Well Installation

2.3.3.1 Design

Groundwater monitoring wells will be installed in the six borings advanced at the Site. The wells will be installed in pairs (one deep, one shallow) at the locations shown on Figures 3 and 9. Pairing shallow and deep wells will enable assessment of vertical groundwater flow gradients between the deep and shallow subsurface. Horizontal flow gradients will be assessed based on the lateral spacing of wells as shown on Figures 3 and 9. It is anticipated that the shallow well screens will be 5 feet in length and will target more permeable alluvium above the Beaumont Formation clay identified during borehole advancement and sampling. Screened intervals in the deep wells will be 10 feet in length and will target water bearing zones immediately below the Beaumont Formation clay.

Monitoring wells will be constructed of typical direct push prepacked, 0.01 inch slotted well screen and appropriate length of riser pipe. All materials will be 1.5 inch inside diameter, flush threaded Schedule 40 polyvinyl chloride (PVC). The well screen assembly will consist of filter sand pack held in place outside the screen by a stainless steel mesh. The annulus above the screen will include a sand buffer zone above the screen, followed by bentonite pellet seal and bentonite slurry to within a few feet of ground surface. The remainder of the annulus will be filled with bentonite/cement to allow placement of the protective well cover. Figure 10 presents typical shallow and deep well construction details.

2.3.3.2 Methods

Monitoring wells will be constructed and installed using direct push techniques consistent with *Groundwater Sampling and Monitoring with Direct Push Technologies* (USEPA 2005b) and standard industry practice.

Following completion of a soil boring, well screen, and riser components will be combined and lowered into the drill casing to result in an assemblage of appropriate length with the screened interval at the desired depth. Annular materials will be pre-packed, placed with tremie pipe, or manually installed, depending on static water level in the casing, in a manner to minimize the risk of material bridging. Each well will be finished with a sloping concrete pad, locking, stickup protective casing, and expandable well cap. As needed, bollards will be installed to protect well locations. The wells will be abandoned in accordance with applicable TCEQ guidance (State of Texas 2010a) immediately after sampling and hydrologic data gathering is completed, as described below. This abandonment is required immediately following the initial round of sampling because of planned removal action construction activities.

2.3.4 Monitoring Well Development

2.3.4.1 Design

Following installation, each monitoring well will be developed in general accordance with *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells* (USEPA 1996) and with standard practice. The goal of well development is to remove fine soils from the annular sand pack and provide a good connection between the native soils and the annular sand pack, thereby enabling collection of representative water quality and hydrology data. Well development will also assist in stabilizing the sand filterpack.

2.3.4.2 Methods

It is anticipated that the monitoring wells will be developed using a combination of continuous pumping and periodic surging with a surge block assembly or similar. As described above the goal is to remove fine-grained materials from the sand filterpack and well interior, resulting in a stable screened region. Development will be initiated following a suitable period of time (i.e., 24 to 48 hours) allowing the annular seal materials to hydrate and properly cure.

During development, groundwater properties will be monitored to assess continued progress in developing the well. Consistent with industry practice, a water quality meter capable of multi parameter monitoring via a continuous flow through cell will be used to monitor turbidity, dissolved oxygen, specific conductance, temperature, pH, and oxidation/reduction potential (ORP) during development. The meter will be calibrated according to manufacturer's instructions stabilization of values for these various parameters and will be the primary indicator that development is complete, consistent with *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells* (USEPA 1996). Generally, well development should continue until the turbidity levels are as low as reasonably feasible and continued development does not result in significant reduction in turbidity. The FSP and USEPA (1996) provide detailed information regarding development activities.

2.3.5 Monitoring Well Sampling

2.3.5.1 Design

After development activities, each well pair will be purged and sampled for COPCs (Table 2). During purging and sampling, conventional water quality data (pH, temperature, conductivity, ORP, etc.) will be collected using a water quality meter calibrated according to manufacturer's instructions. One round of Groundwater Study samples will be collected. Sampling will be conducted following SAP approval, and commensurate with the schedules for other Site activities.

2.3.5.2 Methods

Groundwater Study sampling will be conducted using low flow purge and sampling techniques in accordance with the TCEQ memorandum dated July 31, 2003, *Sample Handling and Preservation Procedures and the Collection Procedures for Groundwater Samples,* the January 5, 1998, TCEQ standard operating procedure *Groundwater Sampling – Filtering, Low Flow Purging*, and USEPA's *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples From Monitoring Wells* (USEPA 1996). Flow rates during each procedure will not exceed development rates and will be approximately 0.1 liters per minute. Samples will be collected using a submersible centrifugal or bladder pump and Teflon discharge tubing.

Similar to development procedures discussed above, turbidity, dissolved oxygen, specific conductance, temperature, pH, and ORP will be monitored during purging to determine that sufficient purge volume had been generated and sampling may take place.

The FSP and USEPA (1996) provide detailed information regarding development activities.

2.3.6 Water Level Monitoring

2.3.6.1 Design

Water level data will be collected from the monitoring wells during installation, development and sampling activities following installation. Concurrent San Jacinto River water level will be obtained from the National Oceanic and Atmospheric Administration

(NOAA) tidal gauge station San Jacinto Battleground State Park (Figure 11) to assess groundwater/surface water interaction.

2.3.6.2 Methods

Water level data will be collected from monitoring wells using a standard electric water level probe and consistent with Water Level Measurement, SOP No. 2043, Revision 0.0 (USEPA 1994).

2.3.7 Decontamination

Non-dedicated sampling, drilling, and monitoring equipment that contacts soils or groundwater will be decontaminated before first use, between sampling intervals, locations, or reading and prior to demobilization from the Site.

As discussed in detail in the FSP Section 2.2.8, decontamination of sampling equipment will be achieved using a water/soap wash, ethanol rinse and hexane rinse. Unless immediately used, sampling equipment will be wrapped in aluminum foil until use.

Drilling tools and equipment will be either steam cleaned between sample locations or decontaminated using the sampling equipment procedure.

All solids and fluids generated during decontamination will be containerized for future characterization and disposal (see Section 2.5 of the FSP).

2.4 Sample Handling and Custody

Upon collection of samples in designated and properly labeled bottles, samples will be placed in sample coolers with water, ice, or Blue Ice-type freezer packs to maintain cooler temperature at 4° C (+/- 2° C). Sample bottles will be wrapped in bubble wrap and placed upright in coolers. Additional bubble wrap will be placed in coolers to protect bottles from impacting other bottles, ice packs, or cooler sides/bottom in transit. As required, temperature blanks will accompany samples in coolers. COC forms will be placed in each cooler describing the samples in the cooler.

After packing, coolers will be sealed with clear tape and affixed with custody seals. It is anticipated sample coolers will be hand-delivered to the laboratory or picked up at the Site by laboratory courier.

Custody of samples as well as custody transfer will be documented using field log books and COC forms. Samples will remain at all times in the custody of field staff, designated courier, or laboratory personnel.

Additional sample handling, packaging, and transport procedures are provided in the FSP.

2.5 Laboratory and Analytical Methods

Soil samples will be analyzed for physical properties (i.e., grain size and TOC) and Groundwater Study samples will be analyzed for physical parameters and COPCs using USEPA SW-846 methods. Table 4 provides bottle, preservative, and holding time information for the various proposed analyses. Groundwater analyses and geotechnical/conventional soil analyses are shown on Table 5. Additional potential analyses for soils are further described in the Soil Study SAP.

All soil samples collected during boring advancement will be analyzed under a normal submittal timeline to the laboratory for grain size and TOC. Soil samples for COPC testing will be archived, as discussed in the Soil Study SAP. QA/QC information for grain size and TOC analyses is provided in the Soil Study SAP.

Groundwater Study samples will be analyzed for COPCs as discussed in Section 1.5.

Table A-1 in Appendix A – FSP provides a sample matrix that indicates analyses for each sample planned for collection.

2.6 Quality Control

2.6.1 Field

Several types of field samples will be collected and analyzed for quality assurance/quality control (QA/QC) purposes. Consistent with the QA/QC approach described in the Soil Study

SAP, field duplicates, equipment filter wipes, filter blanks, and Standard Reference Material (SRM) samples will be analyzed. Additional information regarding collection of field QA/QC samples is provided in the FSP.

Field duplicates and equipment wipes will be collected at a frequency of one per 20 field samples collected. Filter blanks will be submitted at a frequency of one per lot of filters used. An SRM for groundwater will be submitted, if available, once per sampling event. Table A-1 in Appendix A of the FSP provides details of QA/QC samples.

2.6.2 Laboratory

Analytical methods identified for soil and Groundwater Study samples include requirements for laboratory QA/QC procedure. These requirements, based on USEPA and ASTM guidance, include corrective action, control limits, control samples, equipment calibrations, and records retention procedures. The laboratory QA/QC program summarized below is consistent with that presented in the Sediment Study SAP.

The frequency of analysis for laboratory control samples, matrix spike samples, matrix spike duplicates or laboratory duplicates, and method blanks will be one for every 20 samples or one per extraction batch, whichever is more frequent. Surrogate spikes, labeled compounds, and internal standards will be added to every field sample and QC sample, as required. Calibration procedures will be completed at the frequency specified in each method description. Performance-based control limits have been established by the laboratory. These and all other control limits specified in the method descriptions will be used by the laboratory to establish the acceptability of the data or the need for reanalysis of the samples. Laboratory control limits for recoveries of surrogate compounds, matrix spikes, and laboratory control samples, and for relative percent difference (RPD) of matrix spike duplicates and laboratory duplicates, are provided in the laboratory's QA manual.

PARCC parameters (i.e., precision, accuracy or bias, representativeness, completeness, comparability) are commonly used to assess the quality of environmental data. Bias represents the degree to which a measured concentration conforms to the reference value. The results for matrix spikes, laboratory control samples, field blanks, and method blanks will be reviewed to evaluate bias of the data. The following calculation is used to determine percent recovery for a matrix spike sample:

$$\%R = [(M-U) / C] \times 100 \qquad (1\text{-}1)$$

Where:

%R	=	percent recovery
M	=	measured concentration in the spiked sample
U	=	measured concentration in the unspiked sample
C	=	concentration of the added spike

The following calculation is used to determine percent recovery for a laboratory control sample or reference material:

$$\%R = (M / C) \times 100 \qquad (1\text{-}2)$$

Where:

%R	=	percent recovery
M	=	measured concentration in the spiked sample
U	=	measured concentration in the unspiked sample
C	=	concentration of the added spike

Results for field and method blanks can reflect systematic bias that results from contamination of samples during collection or analysis. Any analytes detected in field or method blanks will be evaluated as potential indicators of bias.

Precision reflects the reproducibility between individual measurements of the same property. Precision will be evaluated using the results of matrix spike duplicates, laboratory duplicates, field splits, and field replicates. Precision is expressed in terms of the relative standard deviation for three or more measurements and the RPD for two measurements. The following equation is used to calculate the RPD between measurements:

$$RPD = |[(C1-C2) / ((C1 + C2) / 2)]| \times 100 \qquad (1\text{-}3)$$

Where:

RPD	=	relative percent difference
C1	=	first measurement
C2	=	second measurement

The relative standard deviation is the ratio of the standard deviation of three or more measurements to the average of the measurements, expressed as a percentage. Completeness will be calculated as the ratio of usable data (i.e., unqualified data and U- or J-qualified data) to generated data, expressed as a percentage. Completeness will be calculated for each suite of analytes for each sample type and sampling event.

Additional laboratory QC results will be evaluated to provide supplementary information regarding overall quality of the data, performance of instruments and measurement systems, and sample-specific matrix effects.

QC samples and procedures are specified in each method protocol that will be used for this project. Methods are summarized in Table 5. All QC requirements will be completed by the laboratory as described in the protocols, including the following (as applicable to each analysis):

- Instrument tuning
- Initial calibration
- Initial calibration verification
- Continuing calibration verification
- Calibration or instrument blanks
- Method blanks
- Laboratory control samples
- Internal standards
- Surrogate spikes/labeled compounds
- Matrix spikes
- Matrix spike duplicates or laboratory duplicates

To alert the data user to possible bias or imprecision, data qualifiers will be applied to reported analyte concentrations when associated QC samples or procedures do not meet control limits. Laboratory control limits for the methods that will be used for this Site investigation are provided in Table 6 and in the laboratory QA manuals. Data validation criteria and procedures are described in Section 4.

Method reporting limits (MRLs) reflect the sensitivity of the analysis. Target MRLs for this study are summarized in Table 6. MDLs will be determined by the laboratory for each analyte, as required by USEPA (2009b). MDLs are statistically derived and reflect the concentration at which an analyte can be detected in a clean matrix (e.g., sand or distilled water) with 99 percent confidence that a false positive result has not been reported. MRLs are established by the laboratories at levels above the MDLs for the project analytes. The MRL values are based on the laboratory's experience analyzing environmental samples and reflect the typical sensitivity obtained by the analytical system in environmental samples. For this task, the concentration of the lowest standard in the initial calibration curve for each analysis is at the level of the MRL. This allows reliable quantification of concentrations to the MRL in the absence of matrix interferences.

Analyte concentrations will be reported to the MDL. Analytes detected at concentrations between the MRL and the EDL or MDL will be reported with a J-qualifier to indicate that the value is an estimate (i.e., the analyte concentration is below the calibration range). Non-detects will be reported at the MRL for all other analyses. The MRLs and MDLs will be adjusted by each laboratory, as necessary, to reflect sample dilution, percent moisture, and/or matrix interference.

2.6.3 Representativeness and Comparability of All Data

Representativeness and comparability are qualitative QA/QC parameters. Representativeness is the degree to which data represent a characteristic of an environmental condition. In the field, representativeness will be addressed primarily in the sampling design by the selection of sampling Sites and sample collection procedures. In the laboratories, representativeness will be ensured by the proper handling and storage of samples and initiation of analysis within holding times.

Comparability is the qualitative similarity of one dataset to another (i.e., the extent to which different datasets can be combined for use). Comparability will be addressed through the use of field and laboratory methods that are consistent with methods and procedures recommended by USEPA and are commonly used for soil and groundwater studies.

2.7 Instrument and Equipment Testing, Inspection and Maintenance

Analytical instrument testing, inspection, maintenance, setup, and calibration will be conducted by the laboratory consistent with the requirements identified in the laboratory's SOPs and manufacturer instructions. In addition, each of the specified analytical methods provides protocols for proper instrument setup and tuning, and critical operating parameters. Instrument maintenance and repair will be documented in the maintenance log or record book.

2.8 Inspection and Acceptance of Supplies and Consumables

The quality of supplies and consumables used during sample collection and laboratory analysis can affect the quality of the project data. All equipment that comes into contact with the samples and extracts must be sufficiently clean to prevent detectable contamination, and the analyte concentrations must be accurate in all standards used for calibration and QC purposes.

Pre-cleaned sample jars (with documentation) will be provided by the laboratories. All containers will be visually inspected prior to use, and any suspect containers will be discarded.

Reagents of appropriate purity and suitably cleaned laboratory equipment will also be used for all stages of laboratory analyses. Details for acceptance requirements for supplies and consumables at the laboratories are provided in the laboratory SOPs and QA manuals. All supplies will be obtained from reputable suppliers with appropriate documentation or certification. Supplies will be inspected to confirm that they meet use requirements, and the inspection will be logged in the field book (i.e., for supplies used in the field) or by the laboratories.

2.9 Data Management

As discussed in the Sediment Study and Soil Study SAPs, during field, laboratory, and data evaluation operations, effective data management is critical to providing consistent, accurate, and defensible data and data products. Data management systems and procedures will be used to establish and maintain an efficient organization of the environmental information collected. Procedures and standards for conducting specific data management tasks (i.e., creation, acquisition, handling, storage, and distribution of data) will be documented in a project data management manual. Essential elements of data management and reporting activities associated with the sampling program are discussed in the following sections.

Project data will be maintained in a relational database designed to accommodate all the types of environmental measurements that will be made during this RI/FS, as described in the data management plan, which is included as Appendix B of the RI/FS Work Plan. On-line access to the database will be provided to members of the project team and regulatory oversight.

2.9.1 Field Data

Daily field records (a combination of field logbooks, field forms, GPS records, and COC forms) will make up the main documentation for field activities. Detailed guidelines for entry of information during field sampling are provided in the FSP. Upon completion of sampling, hardcopy notes, and forms will be scanned to create an electronic record for use in creating the draft PSCR. Information on sampling locations, dates, depths, equipment, and other conditions, and sample identifiers, will be entered into the project database. One hundred percent of hand-entered data will be verified based on hard copy records. Electronic QA checks to identify anomalous values will also be conducted following entry.

2.9.2 Laboratory Data

The analytical laboratories will each submit data in both electronic and hard-copy format. The project database administrator or his designated data manager will provide the desired format for EDDs to the laboratories, and the project data manager and laboratory coordinator will discuss these specifications with laboratory QA managers prior to data delivery and tailor them as necessary to specific laboratory capabilities. QA checks of format and consistency will be applied to EDDs received from the laboratory. After any issues have been resolved, the data will be loaded into the project database. Each dataset loaded will be linked to the electronic document of the relevant laboratory data package. Data summaries will be produced from the database for use by data validators. Validators will return edited versions of these summaries, and the edits will then be incorporated into the database. An automated change log will be maintained by the database so that the history of all such edits is maintained, and the provenance of each data value can be determined.

2.10 Reporting

Qualitative (i.e., field logs, observations) and quantitative (i.e., sample results, measurements) will be evaluated, synthesized and reported in the Preliminary Site Characterization Report as described in the RI/FS Work Plan.

3 ASSESSMENT AND OVERSIGHT

This task will rely on the knowledge and expertise of the SJRWP technical team, as described in the RI/FS Work Plan (Anchor QEA and Integral 2010). The field teams and laboratory will stay in verbal contact with the project managers and QA coordinator throughout this task. This level of communication will serve to keep the management team informed about activities and events, and will allow for informal but continuous task oversight.

Assessment and oversight activities for both the northern and southern impoundments are identical, pending confirmation of the Site history and CSM for the potential southern impoundment.

3.1 Assessment and Response Actions

Assessment activities will include readiness reviews by the field lead prior to sampling, by the database administrator prior to release of the final data to the data users, and internal review while work is in progress. An informal technical systems audit may be conducted if problems are encountered during any phase of this project.

The first readiness review will be conducted by the field lead prior to field sampling to verify that all field equipment is ready for transfer to the Site. The field lead will also verify that the field team and any subcontractors have been scheduled and briefed and that the contracts for the subcontractors have been signed by both parties. Any deficiencies noted during this readiness review will be corrected prior to initiation of sampling activities.

The second readiness review will be completed by the database administrator before final data are released for use to verify that all results have been received from each laboratory, data validation and data quality assessment have been completed for all of the data, and data qualifiers have been entered into the database and verified. Any deficiencies noted during this review will be corrected by the database administrator, the task QA coordinator, or their designee. Data will not be released for final use until all data have been verified and validated. No report will be prepared in conjunction with the readiness reviews. However, the SJRWP project coordinator and data users will be notified when the data are ready for use.

Technical review of intermediate and final work products generated for this task will be completed throughout the course of all sampling, laboratory, data validation, data management, and data interpretation activities to ensure that every phase of work is accurate and complete and follows the QA procedures outlined in this QAPP. Any problems that are encountered will be resolved between the reviewer and the person completing the work. Any problems that cannot be easily resolved or that affect the final quality of the work product will be brought to the attention of the SJRWP technical team coordinator and SJRWP project coordinator.

The laboratory will be required to have implemented a review system that serves as a formal surveillance mechanism for all laboratory activities. Details will be provided in the laboratory QA plan.

Technical system audits may be conducted if serious problems are encountered during sampling or analysis operations. If completed, these audits will be conducted by the task QA coordinator or designee, or by the laboratory, as appropriate. These audits may consist of on-Site reviews of any phase of field or laboratory activities or data management. Results of any audits will be provided in the draft PSCR.

Any task team member who discovers or suspects a nonconformance is responsible for reporting the nonconformance to the task manager, the task QA coordinator, or the laboratory project or QA manager, as applicable. The task QA coordinator will ensure that no additional work dependent on the nonconforming activity is performed until a confirmed nonconformance is corrected. Any confirmed nonconformance issues will be relayed to the SJRWP technical team coordinator.

3.2 Reports to Management

The laboratory will keep the laboratory coordinator informed of their progress on a weekly basis. The laboratory will provide the following information:

- Inventory and status of samples held at the laboratory in spreadsheet format by sample delivery group
- Summaries of any laboratory QC data outside of control limits and any corrective

actions implemented

- Descriptions and justification for any significant changes in methodology or QA/QC procedures.

The task QA coordinator will provide this information to the Integral project manager.

Individual laboratories will be required to have implemented routine systems of reporting nonconformance issues and their resolution. These procedures are described in the laboratory QA manual. Laboratory nonconformance issues will also be described in the PSCR if they affect the quality of the data.

Data packages and EDDs will be prepared by each laboratory upon completion of analyses for each sample delivery group. The case narrative will include a description of any problems encountered, control limit exceedances (if applicable), and a description and rationale for any deviations from protocol. Copies of corrective action reports generated at the laboratory will also be included with the data package.

Data validation reports will be prepared following receipt of the complete laboratory data packages for each sample delivery group. These reports will be provided to the task QA coordinator when validation is completed for each parameter. A summary of any significant data quality issues will be provided to USEPA with the data report.

4 DATA VALIDATION AND USABILITY

Data generated in the field and at the laboratories for work at the northern and southern impoundments will be verified and validated according to criteria and procedures described in this section, and as described in the future addendum submitted on behalf of IPC. Data quality and usability will be evaluated, and a discussion will be included in the PSCR.

4.1 Criteria for Data Review, Verification, and Validation

Field and laboratory data for this task will undergo a formal verification and validation process. All entries into the database will be verified. All errors found during the verification of field data, laboratory data, and the database will be corrected prior to release of the final data.

Data verification and validation for dioxins and furans, metals, and organic compounds will be completed in accordance with Guidance on Environmental Data Verification and Validation (USEPA 2002a) and according to methods described in USEPA's National Functional Guidelines for inorganic and organic data review (USEPA 2004, 2005a, 2008). Performance-based control limits established by the laboratories and control limits provided in the method protocols will be used to evaluate data quality and determine the need for data qualification. Performance-based control limits are established periodically by the laboratory. Current values will be provided in the laboratory QA plans, as applicable.

Results for field splits will be evaluated against a control limit of fifty percent RPD. Data will not be qualified as estimated if this control limit is exceeded, but RPD results will be tabulated, and any exceedances will be discussed in the PSCR. Equipment wipe blanks will be evaluated and data qualifiers will be applied in the same manner as method blanks, as described in the functional guidelines for data review (USEPA 2004, 2005a, 2008).

Data will be rejected if control limits for acceptance of data are not met, as described in (USEPA 2004, 2005a, 2008).

4.2 Verification and Validation Methods

Both the chemical and conventional analyses will undergo verification and validation, as described below.

Field data will be verified during preparation of samples and COC forms. Field data and COC forms will be reviewed daily by the field lead. After field data are entered into the project database, 100 percent verification of the entries will be completed by a second party to ensure the accuracy and completeness of the database. Any discrepancies will be resolved before the final database is released for use.

Data verification and validation will be completed as described in Section 6.1 by either Integral or a data validation firm. The first data package generated will be fully validated, equivalent to a Stage 4 validation as described in USEPA (2009c). If no major problems are encountered during validation of this package, full validation will be completed at a rate of approximately 30 percent of the dioxin and furan samples. Validation for the remaining data will be based on a review of the sample and QC data, equivalent to a Stage 2B validation. If problems are encountered, the laboratory will be contacted for resolution. Additional full validation will be completed if required to fully assess the quality of the data to verify that the laboratory errors have been addressed.

The accuracy and completion of the database will be verified at the laboratory when the EDDs are prepared and again as part of data validation. Ten percent of entries to the database from laboratory EDDs will be checked against hard-copy data packages. In addition to verification of field and laboratory data and information, data qualifier entries into the database will be verified. Any discrepancies will be resolved before the final database is released for use.

Reporting limits for non-detects will be compared to the MRL goals to evaluate method sensitivity for each sample. Any exceedance of actual MRLs over the target MRLs will be discussed in the letter report.

4.3 Reconciliation with User Requirements

Both the chemical and conventional analyses will undergo reconciliation with user requirements, as described below.

The goal of data validation is to determine the quality of each data result and to identify those that do not meet the task measurement quality objectives. Nonconforming data may be qualified as estimated (i.e., a J-qualifier will be applied to the result) or rejected as unusable (i.e., an R-qualifier will be applied to the result) during data validation if criteria for data quality are not met. Rejected data will not be used for any purpose. An explanation of the rejected data will be included in the draft Preliminary Site Characterization Report (PSCR).

Data qualified as estimated will be used for all intended purposes and will be appropriately qualified in the final project database. However, these data are less precise or less accurate than unqualified data. Data users, in cooperation with the SJRWP technical team coordinator and the task QA coordinator, are responsible for assessing the effect of the inaccuracy or imprecision of the qualified data on statistical procedures and other data uses.

5 SCHEDULE

Based on the schedule provided in the RI/FS Work Plan, the following milestones are anticipated for the groundwater-related work discussed in this Groundwater Study SAP. These dates are subject to change based on unforeseen events, or mutually-agreed schedule modifications. Given recent request by USEPA to include assessment of the potential southern impoundment in the Groundwater Study SAP, additional schedule information is provided, below. Specific schedule considerations for the Groundwater Study SAP addendum to be submitted on behalf of IPC and implementation thereof will be discussed with USEPA, the current goal being inclusion of those study results in the PSCR.

- October 1, 2010 – Submission of this Draft Groundwater Study SAP for Agency review
- November 8, 2010 – Resubmission of this Groundwater Study SAP for Agency review
- November 12, 2010 – Provision of Agency comments.
- November 26, 2010 – Submission of Final Groundwater Study SAP
- December 3, 2010 – Final Groundwater Study SAP approval by Agency
- December 6, 2010 – April 29, 2011 – Groundwater Study SAP implementation, including data management
- July – November 2011 – Draft and Final PSCR preparation, review, and approval

An accelerated schedule may be required to coordinate with planned removal action construction activities.

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TABLES

Table 1

Registered TWDB Groundwater Wells Near The Site

TWDB Well Number	Owner	Top of Well Elevation (feet)	Well Depth (feet)	Aquifer
6516506	Harris County WCID 1	40	537	Lower Chicot
6516811	Vahlco Corp	32	350	Lower Chicot
6516812	C. Fitzgerald	30	125	Upper Chicot

Please also refer to Figure 4.

Table 2
Primary and Secondary COPCs – Northern Impoundments

Type of COPC	Chemical
Primary	Dioxins and furans Aluminum Arsenic Barium Cadmium Chromium Cobalt Copper Lead Magnesium Manganese Mercury Nickel Vanadium Zinc Bis (2-ethylhexyl) phthalate
Secondary	PCBs Acenaphthene Carbazole Chloroform 2,4-Dichlorophenol Fluorene Naphthalene Pentachlorophenol Phenanthrene Phenol 2,3,4,6-Tetrachlorophenol 2,4,6-Trichlorophenol Hexachlorobenzene 2,4,5-Trichlorophenol

Table 3
Number of Locations Sampled-Northern Impoundments
Groundwater Study SAP
San Jacinto River Waste Pits Superfund Site

Sample Group	Sampling Method	Number of Locations	Approximate Coordinates [b]	Sample Locations	Analytes	Study Elements
Site soils[a], COPCs[d]	Direct push rig and standard sampling tools	3 borings	13857373 N / 3216663 E	"Deep" borings advanced for monitoring well construction in three locations at site perimeter spaced to allow groundwater quality and flow characterization	Grain size and TOC[a]	Nature and extent
			13857791 N / 3217053 E			
Groundwater, COPCs[d]	Low flow sampling techniques, screened zone of wells	6	13857112 N / 3217206 E	Monitoring well pairs installed in three locations at site perimeter spaced to allow groundwater quality and flow characterization	Primary and secondary COPCs[d]	Nature and extent

Notes

COPC = chemical of potential concern (see Table 2)

[a] See Soil Study SAP for additional details on soil sampling and analyses.

[b] Three sampling locations are planned, consisting of a deep and shallow boring pair at each location. Monitoring wells will be installed in each boring. Soil sampling will be conducted in only the deep boring in each pair. See Figures 3 and 9.

[c] Locations are approximate; as-built locations will be surveyed following field work. Coordinates in Texas South Central NAD 83, US Survey Feet.

[d] See SAP Section 1.5

Table 4
Sample Containers, Preservation, and Holding Time Requirements
Groundwater Study SAP
San Jacinto River Waste Pits Superfund Site

Matrix	Container [a] Type	Size	Laboratory	Parameter	Preservation	Holding Time	Sample Size [b]
Water (groundwater)							
	HDPE	500 mL	TBD	Metals (total and dissolved)	4±2°C, HNO_3 to pH<2	6 months	100 mL
	HDPE	500 mL	TBD	Mercury	4±2°C, HNO_3 to pH<2	28 days	100 mL
	AG	1L	TBD	Dioxins/furans	4±2°C	1 year/1 year [e]	1L
	AG	1L	TBD	Semivolatile organic compound	4±2°C	14 days	500 mL
	AG	1L	TBD	PCBs	4±2°C	14 days	500 mL
Soil[g]							
	WMG	8 oz.	TBD	TOC	4±2°C/ Deep frozen (-20°C)	6 months	10 g
	WMG	16 oz.	TBD	Grain size	4±2°C	6 months	500 g
Equipment Filter Wipe Blanks							
	HDPE	4 oz.	TBD	Metals	4±2°C	6 months	1 wipe
	HDPE	4 oz.	TBD	Mercury	4±2°C	28 Days	1 wipe
	AG	4 oz.	TBD	Dioxins/furans	4±2°C	1 year/1 year [e]	1 wipe
	AG	4 oz.	TBD	PCBs	4±2°C	7 days/40 days [e]	1 wipe
	AG	4 oz.	TBD	Semivolatile organic compound	4±2°C	7 days/40 days [e]	1 wipe

Notes

AG = amber glass
HDPE = high density polyethylene
NA = not applicable
TBD = to be determined
WMG = wide mouth glass

[a] The size and number of containers may be modified by the analytical laboratory.
[b] Sample sizes may be modified one laboratory selection is made.
[c] Samples will be shipped to the laboratory on ice at 4±2°C. Once received at the laboratory, samples will be stored at -20°C.
[d] Extracts will be stored at -10°C.
[e] Holding time for samples prior to extraction/ holding time for extracts.
[f] Published holding time does not exist. Holding time shown is based on best professional judgment.
[g] See Soil Study SAP for additional details on soil sampling and analyses.

Table 5
Proposed Laboratory Methods for Samples
Groundwater Study SAP
San Jacinto River Waste Pits Superfund Site

Matrix	Parameter	Laboratory	Sample Preparation		Quantitative Analysis	
			Protocol	Procedure	Protocol	Procedure
Water (groundwater)	**Metals (unfiltered)**					
	Aluminum, arsenic, barium, cadmium, chromium, cobalt, copper, lead, magnesium, manganese, nickel, vanadium, zinc	TBD	EPA 3050	Strong acid digestion	EPA 6010B/6020	ICP/ICP-MS
	Mercury	TBD	EPA 7470A	Acid digestion/oxidation	EPA 7471A	CVAA
	Organics (unfiltered)					
	Dioxins /furans	TBD	EPA 1613B	Separatory funnel/Soxhlet/solid phase extraction	EPA 1613B	HRGC/HRMS
	PCB Aroclors	TBD	EPA 3510C/3520C/3535A	Separatory funnel/continuous liquid-liquid/solid phase extraction	EPA 8082	GC-ECD
	SVOCs	TBD	EPA 3510C/3520C/3535A	Separatory funnel/continuous liquid-liquid/solid phase extraction	EPA 8270C	GC/MS
Soil[1]	**Geotechnical/Conventional**					
	Grain size	TBD	NA	NA	ASTM D-422 and D-1140 with USEPA (1986) modifications	Sieves and hydrometer method
	TOC	TBD	Plumb, 1981/9060	dry and grind	Plumb, 1981/9060	dry and grind

Notes

1. Grain size and TOC samples will be analyzed. All other soil samples will be archived. See Soil Study SAP for additional details on soil sampling.

CVAA = cold vapor atomic absorbtion spectrometry
EPA = U.S. Environmental Protection Agency
GC/ECD = gas chromatograpthy/electron capture detector
GC/MS = gas chromatography/mass spectrometry
HRGC = high-resolution gas chromatography
HRMS = high-resolution mass spectrometry
ICP = inductively coupled plasma-atomic emission spectrometry
ICP/MS = inductively coupled plasma/mass spectrometry
NA = not applicable
SVOC = semivolatile organic compound
TBD = to be determined

Table 6

Analytes, Analytical Concentration Goals (ACGs), Method Reporting Limits (MRL), and Method Detection Limits (MDL) for Groundwater Samples

Groundwater Study SAP

San Jacinto River Waste Pits Superfund Site

Analyte	CAS Number	ACG (ug/L)[a]		MRL	MDL
Metals					
Aluminum	7429-90-5	50-200	c	50	40
Arsenic	7440-38-2	10	b	10	4
Barium	7440-39-3	2000	b	5	0.5
Cadmium	7440-43-9	5	b	5	0.9
Chromium	7440-47-3	100	b	5	2
Cobalt	7440-48-4	7.3	f	1	0.4
Copper	7440-50-8	1000	f	10	5
Lead	7439-92-1	15	b, e	10	4
Magnesium	7439-95-4	NA		20	0.4
Manganese	7439-96-5	50	f	5	0.7
Nickel	7440-02-0	490	f	20	3
Vanadium	7440-62-2	1.7	f	0.2	0.03
Zinc	7440-66-6	5000	c	10	2
Mercury	7439-97-6	2	b	0.2	0.02
Organics					
Dioxins/furans					
Dioxins and Furans (as 2,3,7,8 TCDD)	1746-01-6	3.00E-05	b	1.00E-05	3.70E-07
Total PCBs	1336-36-3	0.5	b	0.2	0.049
Semivolatile Organic Compounds					
Acenaphthene	83-32-9	1500	f	0.02	0.0044
Carbazole	86-74-8	46	f	0.02	0.0045
2,4-Dichlorophenol	120-83-2	73	f	10	0.297
Fluorene	86-73-7	980	f	0.02	0.0038
Naphthalene	91-20-3	0.14	d	0.2	0.022
Pentachlorophenol	87-86-5	1	b	1	0.34
Phenanthrene	85-01-8	730	f	10	0.482
Phenol	108-95-2	7300	f	10	0.324
2,3,4,6-Tetrachlorophenol	58-90-2	730	f	10	0.55
2,4,6-Trichlorophenol	88-06-2	6.1	d	0.5	0.058
Hexachlorobenzene	118-74-1	1	b	0.2	0.022
2,4,5-Trichlorophenol	95-95-4	2400	f	10	0.381
Bis(2-ethylhexyl)phthalate	117-81-7	6	b	1	0.13

Notes:

Both National Drinking Water Standards and TCEQ TRRP PCLs were reviewed; the more stringent standard has been applied.

MRLs/MDLs for Vanadium and Naphthalene may be revised during laboratory evaluation.

Additional conventional data consisting of turbidity, dissolved oxygen, specific conductance, temperature, pH and oxidation/reduction potential will be collected with field instruments during development, purging and sampling activities. See FSP.

a. National Drinking Water Standards were adopted where available. In the case that no primary or secondary MCL was available USEPA risk based screening levels for tap water were assumed.

b. Primary MCL

c. Secondary MCL

d. USEPA risk-based screening level for tap water

e. Primary MCL is an Action Level defined as the level of lead or copper which, if exceeded in over 10% of the homes tested, triggers treatment for corrosion control.

f. PCL for residential groundwater ingestion. Where available, TCEQ adopts the National secondary MCL in the case that this value is lower than the primary MCL or risk based value derived.

g. Texas value is for thallium and compounds (as thallium chloride).

CAS = Chemical Abstract Service

MCL = Maximum Contaminant Level

PCL = Protective Concentration Level

TCEQ = Texas Commission on Environmental Quality

TRRP = Texas Risk Reduction Program

USEPA = United States Environmental Protection Agency

References:

USEPA. 2009d. 2009 Edition of the Drinking Water Standards and Health Advisories. EPA 822-R-09-011. Office of Water. United States Environmental Protection Agency. Washington, DC. Available at: http://water.epa.gov/action/advisories/drinking/drinking_index.cfm#dw-standards. Used as primary source.

USEPA. 2010b. Regional Screening Levels. United States Environmental Protection Agency. Available at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm. Used when MCL not available from USEPA 2009.

TCEQ. 2010b. TRRP PCLs. Tables 3. Texas Commission on Environmental Quality. Available at: http://www.tceq.state.tx.us/remediation/trrp/trrppcls.html

TCEQ. 2009. TCEQ Regulatory Guidance. Tier 1 PCL Tables. RG-366/TRRP-23. Texas Commission on Environmental Quality. Available at: http://www.tceq.state.tx.us/comm_exec/forms_pubs/pubs/rg/rg-366_trrp_23.html/at_download/file

FIGURES

P:\Projects\C643 SJWaste IPC\Production MXDs\GW SAP\Figure 1 overview.mxd - 11/8/2010 @ 9:11:14 AM

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0 800

Scale in Feet

US EPA's Preliminary Site Boundary

Original (1966) Perimeter of the Northern Impoundments

Area of Groundwater Investigation South of I-10

* Designation of the sand separation area is intended to be a general reference to areas in which such activities are believed to have taken place based on visual observations of aerial photography from 1998 through 2002.

FEATURE SOURCES:
Aerial Imagery: 0.5-meter. Photo Date: 01/14/2009
Texas Strategic Mapping Program (StratMap), TNRIS

Figure 1
Overview of Current Site
SJRWP Groundwater Study SAP
SJRWP Superfund Site/MIMC and IPC

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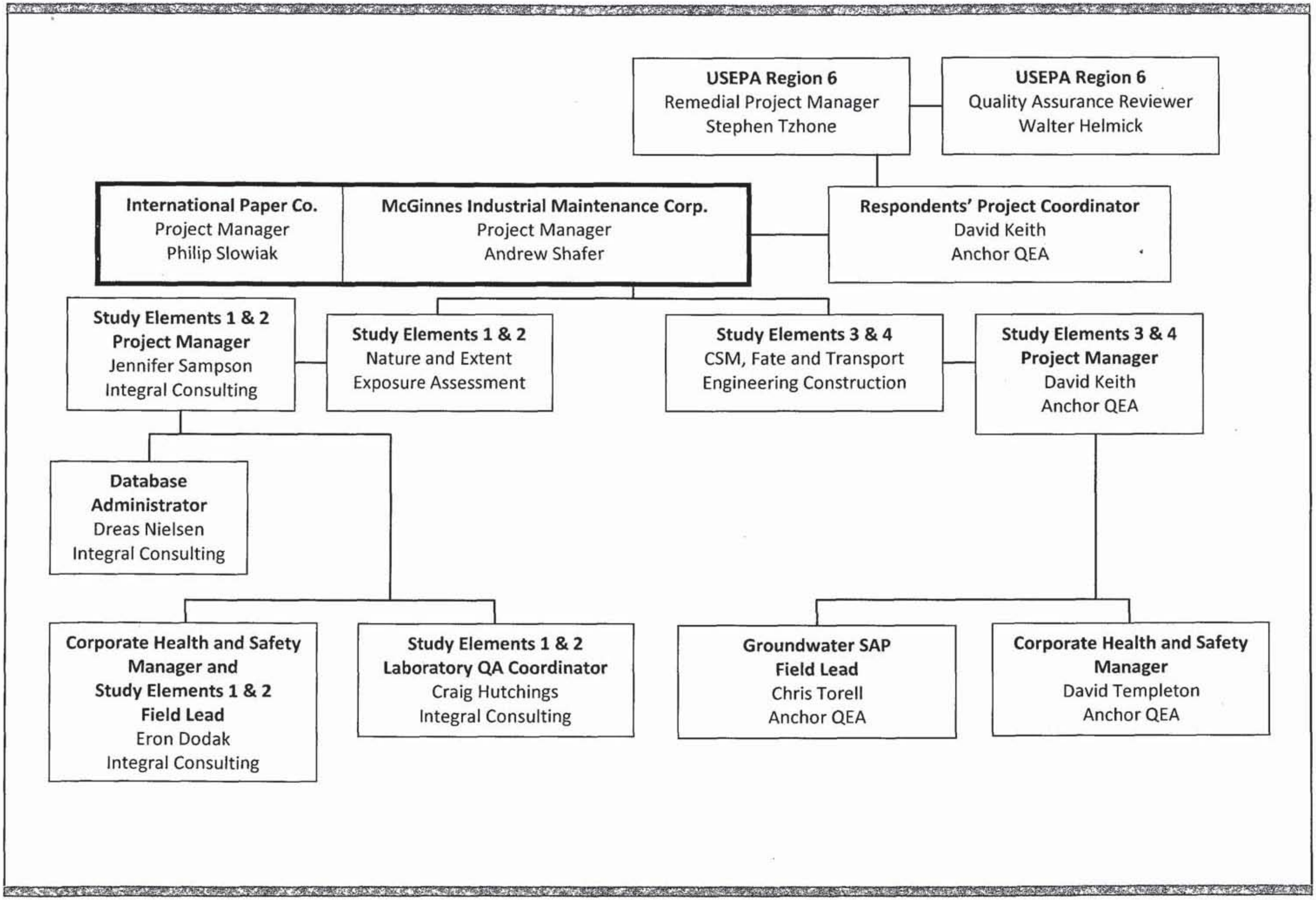
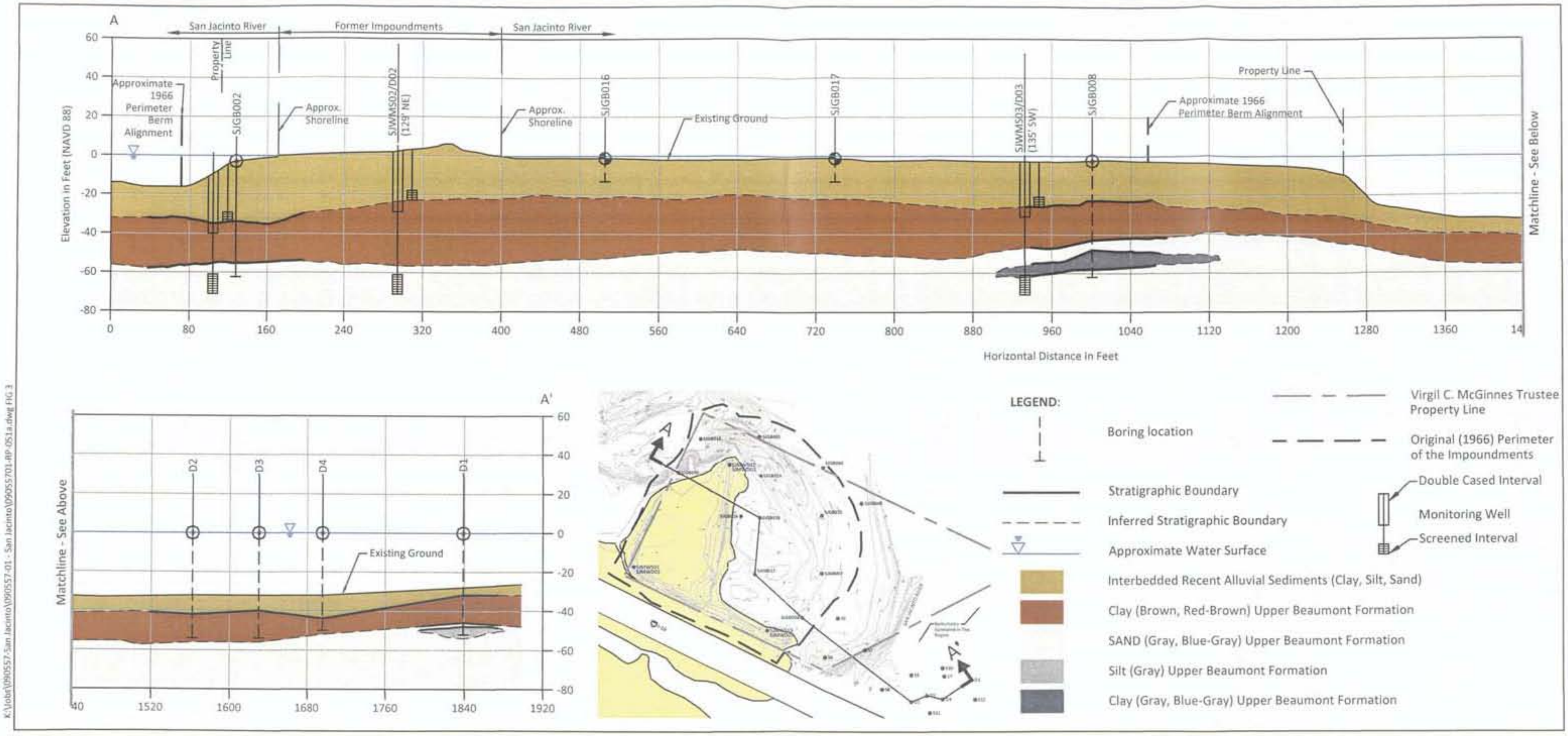


ANCHOR QEA integral consulting inc

Figure 2
Project Organization Chart
SJRWP Groundwater SAP
SJRWP Superfund/MIMC and IPC



HORIZONTAL DATUM: Texas South Central NAD 83, US Survey Feet.
VERTICAL DATUM: NAVD 88.

NOTES:

1. Proposed well locations are shown for illustration purposes. Well construction details may be adjusted based on field conditions.
2. Elevations are approximate.

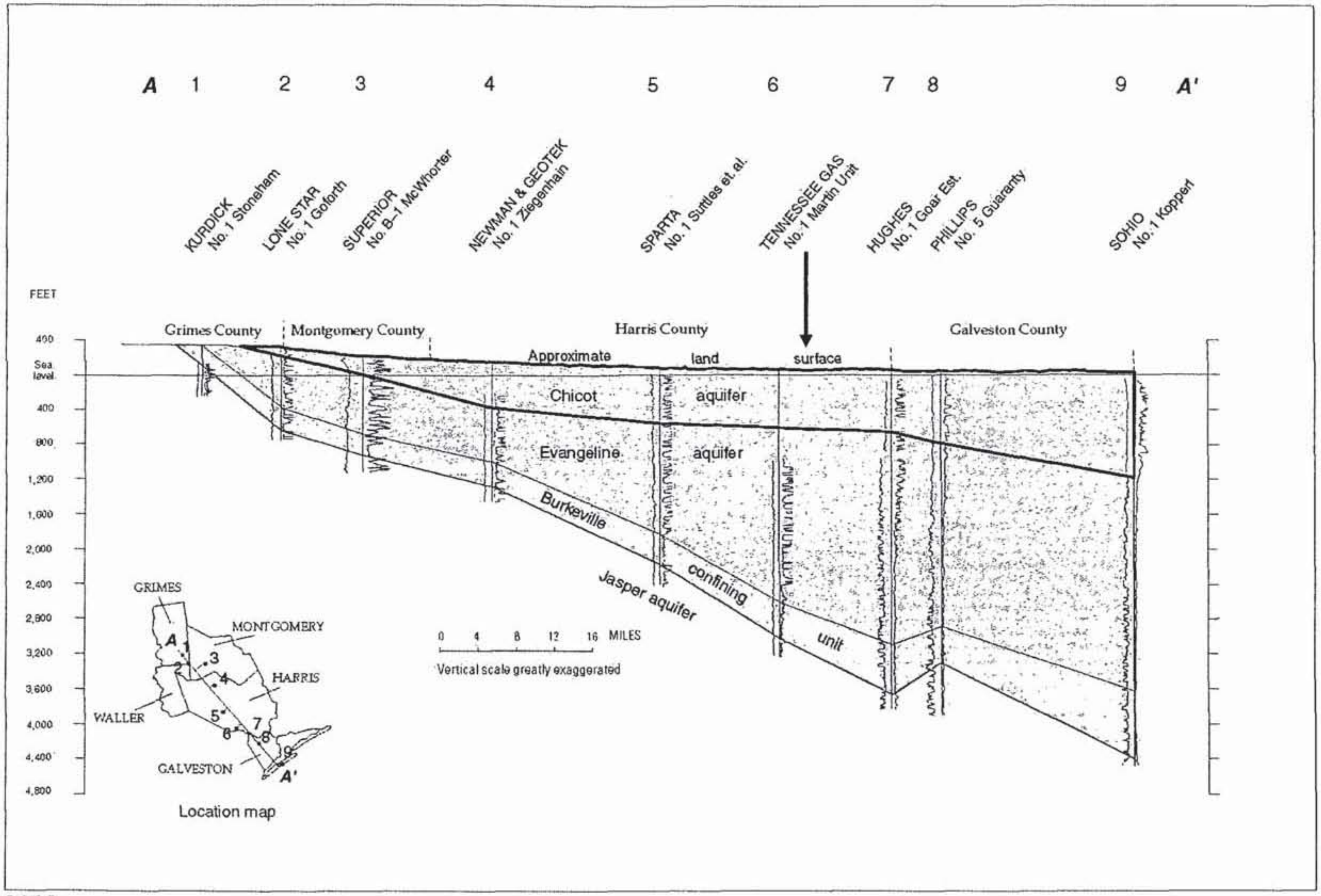
LEGEND:

BGS Below Ground Surface
SJGB Borings by MIMC / IPC
D Borings by TxDOT

Horizontal Scale in Feet
0 100
0 50
Vertical Scale in Feet
(Vertical Exaggeration x2)

ANCHOR QEA

Figure 3
Cross Section and Cross Section Location
SJRWP Groundwater Study SAP
SJRWP Superfund Site/MIMC and IPC



From USGS, 2002

↓ Indicates Approximate Site Location

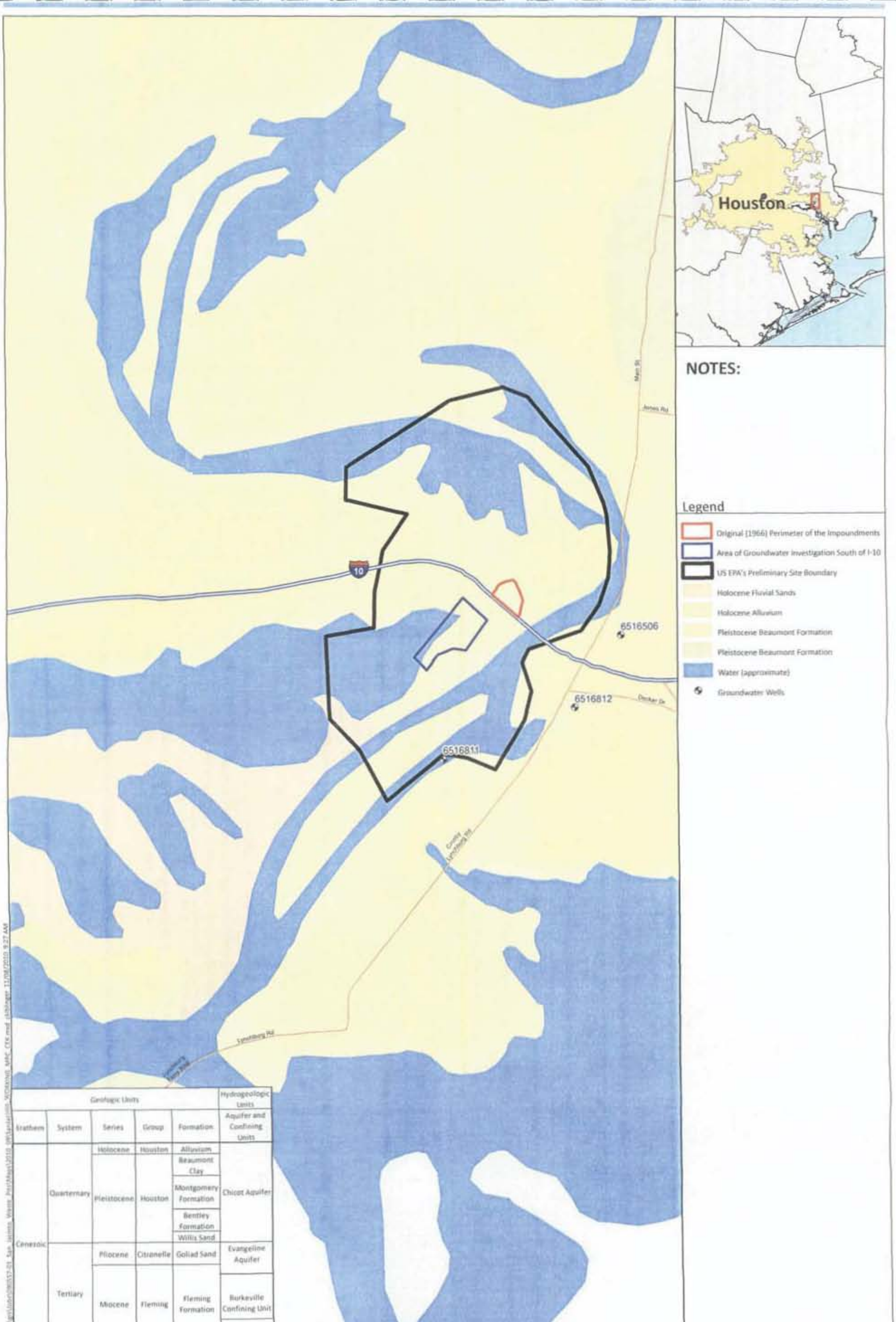
ANCHOR QEA integral consulting inc

Figure 4

Generalized Cross-Section Showing Hydrogeologic Units of Interest in Houston, Texas Area

SJRWP Groundwater Study SAP

SJRWP Superfund Site/MIMC and IPC



Geologic Units					Hydrogeologic Units
Erathem	System	Series	Group	Formation	Aquifer and Confining Units
Cenozoic	Quaternary	Holocene	Houston	Alluvium	Chicot Aquifer
		Pleistocene	Houston	Beaumont Clay	
				Montgomery Formation	
				Bentley Formation	
				Willis Sand	
	Tertiary	Pliocene	Citronelle	Goliad Sand	Evangeline Aquifer
		Miocene	Fleming	Fleming Formation	Burkeville Confining Unit
					Jasper Aquifer

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integral

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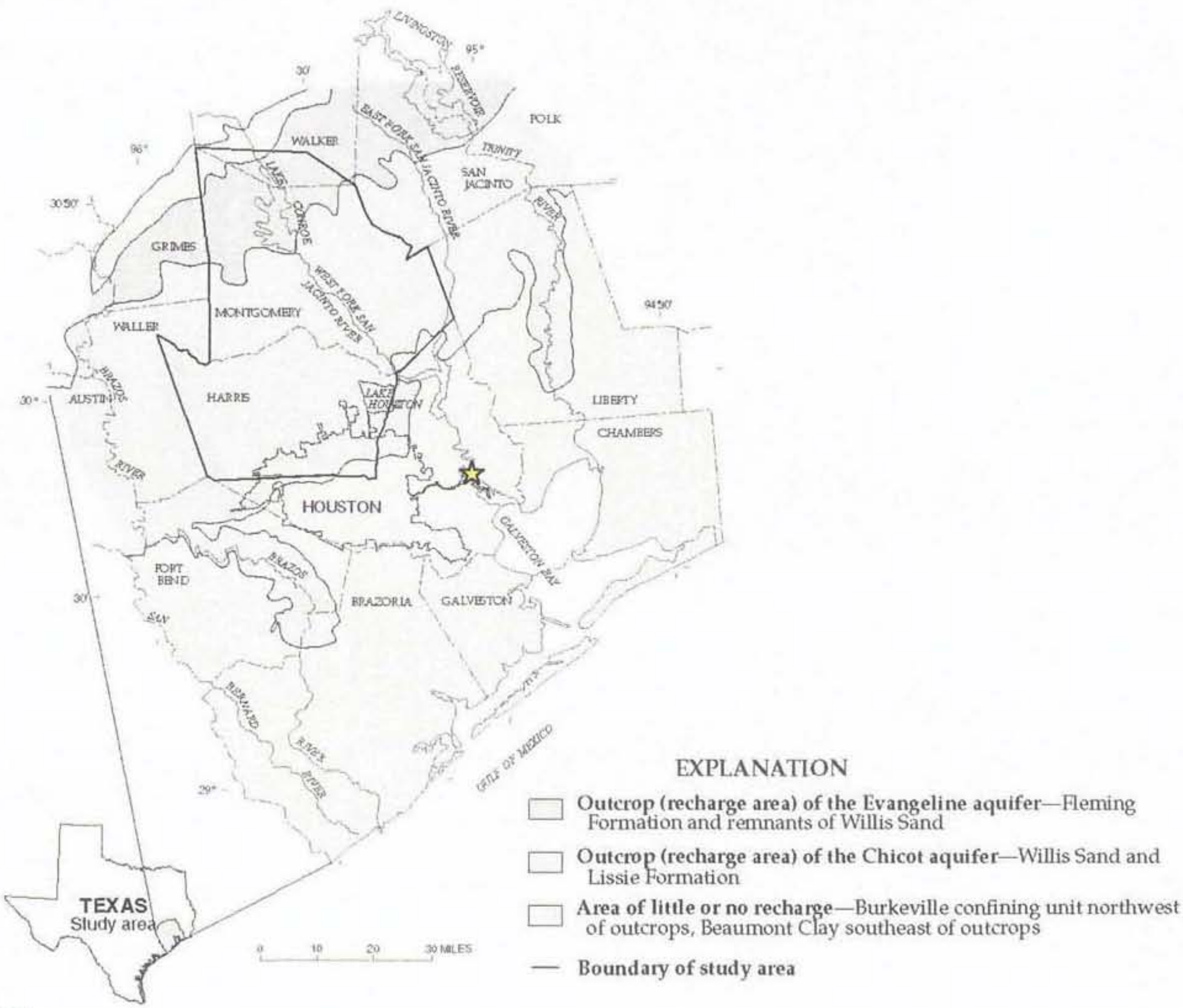
Figure 5

Surficial Geology and Nearby Groundwater Wells
SJRWP Groundwater Study SAP
SJRWP Superfund Site/ MIMC and IPC



From USGS, 1997

☆ Approximate Site Location

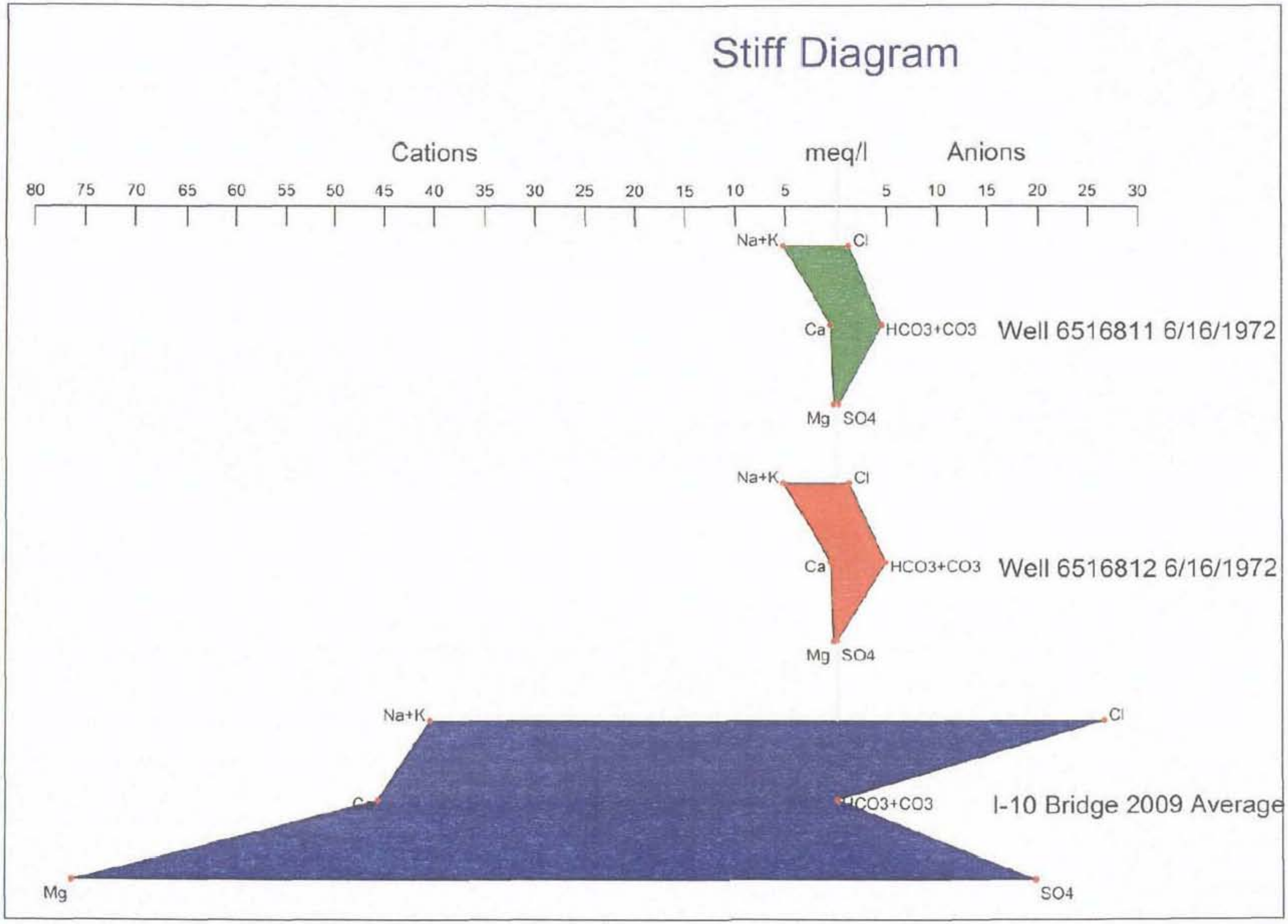
ANCHOR QEA integral

Figure 6

Map of Recharge Areas in Chicot and Evangeline Aquifers North of Houston, Texas Area

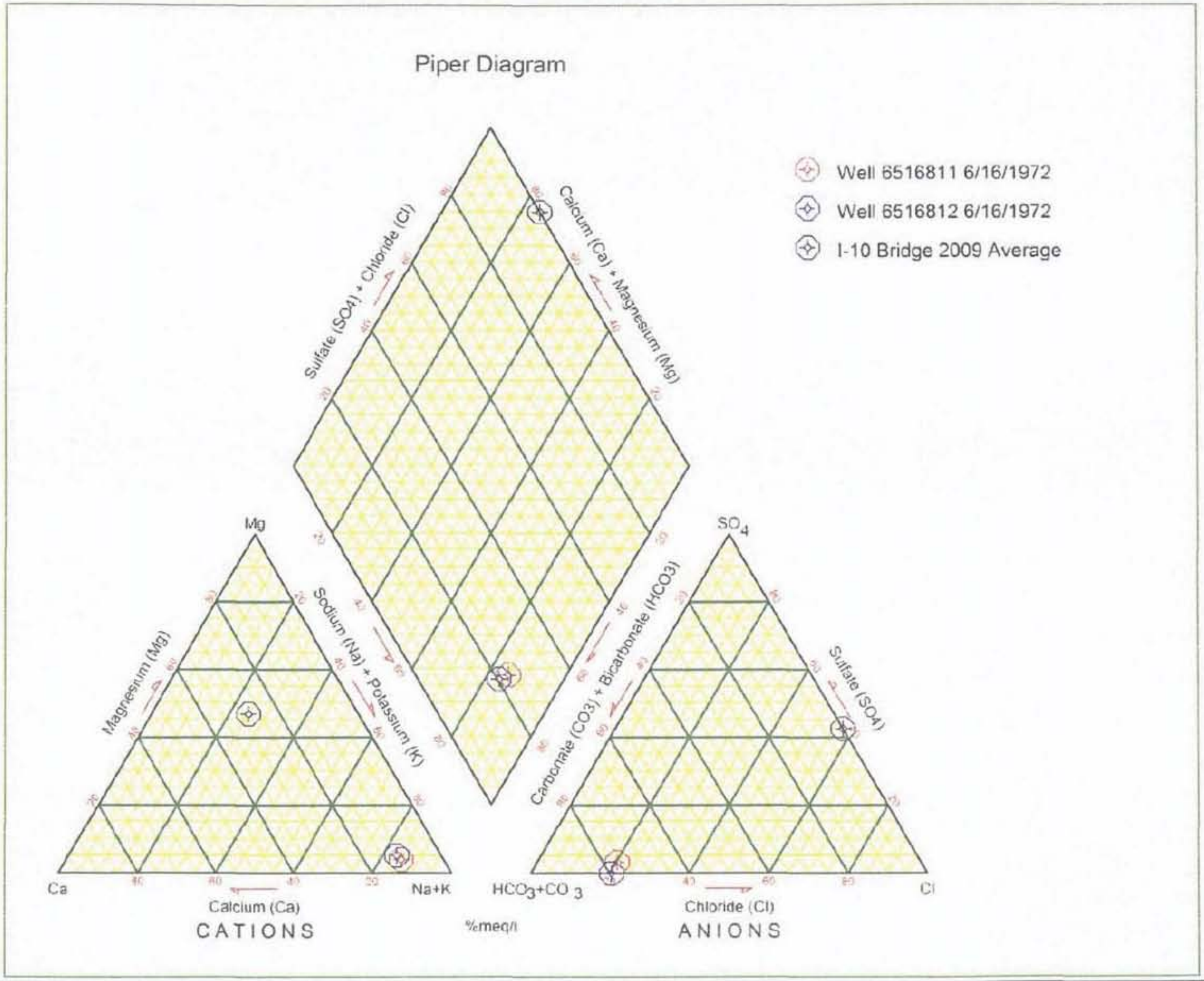
SJRWP Groundwater Study SAP

SJRWP Superfund Site/MIMC and IPC



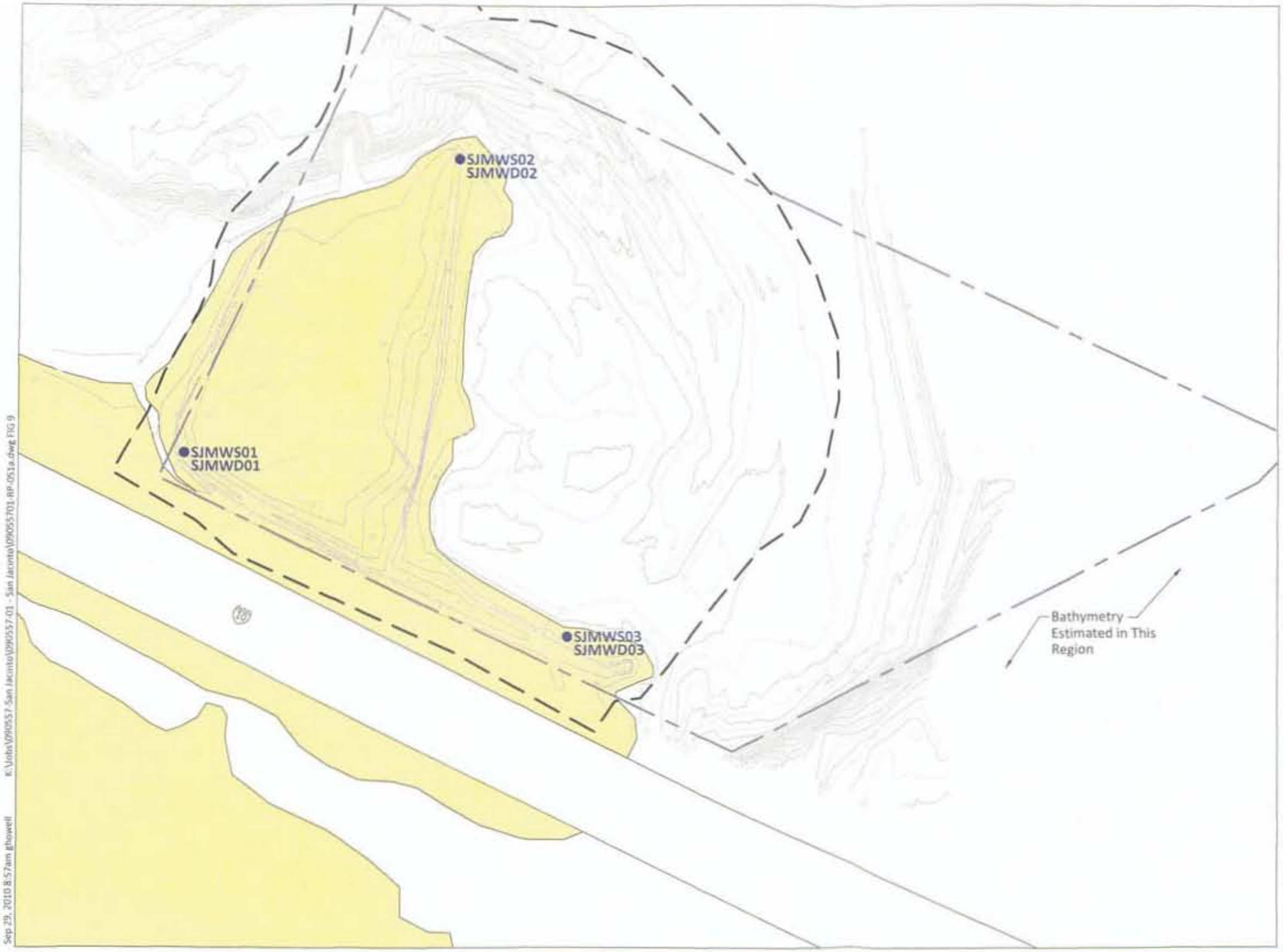
\\gfalls1\gfalls\San_Jacinto\documents\Draft_wkpl\Figure-2-8_Cross-section_20100401_MPC.docx

Figure 7
Stiff Diagrams of Private Wells and San Jacinto River
SJRWP Groundwater Study SAP
SJRWP Superfund Site/MIMC and IPC



ANCHOR QEA integral

Figure 8
Piper Diagram of Private Wells and San Jacinto River
SJRWP Groundwater Study SAP
SJRWP Superfund Site/MIMC and IPC



Proposed Well Pairs	Easting	Northing
SJWMS01/D01	3216663.9445	13857373.7160
SJWMS02/D02	3217053.9683	13857791.3563
SJWMS03/D03	3217206.9071	13857112.8596

LEGEND:

Approximate 1966 Berm Alignment Perimeter

Virgil C. McGinnes Trustee Property Line

Approximate Limit of Vegetated Area (Shoreline)

SJMWS01 SJMWD01 Monitoring Well Pair (Proposed)

0 150 Scale in Feet

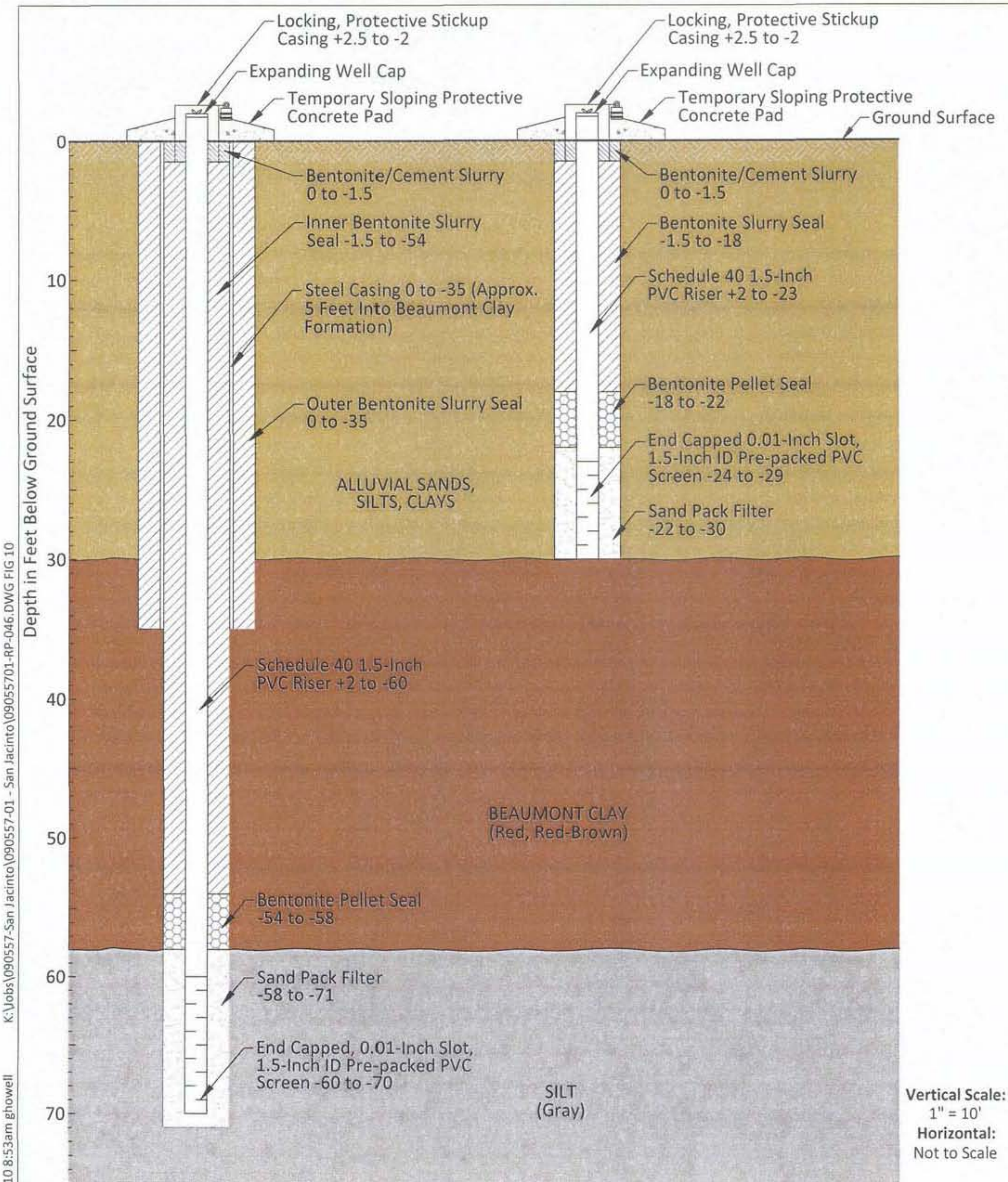
SOURCE: Drawing prepared from electronic file provided by US Army Corps of Engineers.
HORIZONTAL DATUM: Texas South Central NAD 83, US Survey Feet.
VERTICAL DATUM: NAVD 88.
NOTE:
Proposed boring locations are depicted in gray scale.

Sep 29, 2010 8:57am gthowell K:\Jobs\090557-San Jacinto\090557-01 - San Jacinto\09055701-RP-051a.dwg FIG 9

ANCHOR QEA

integral

Figure 9
Proposed Monitoring Well Pairs
SJRWP Groundwater Study SAP
SJRWP Superfund Site/MIMC and IPC



Notes:

1. Presence and depths of lithology and components may vary based on field conditions.
2. Direct Push methods will be used to install wells. Actual construction details may vary slightly from those depicted.

Figure 10

Typical Deep and Shallow Well Construction Details

SJRWP Groundwater Study SAP

SJRWP Superfund Site/MIMC and IPC

P:\Projects\C643 SJWaste IPC\Production MXDs\GW SAP\Figure 4 Tidal Gauge.mxd - 11/8/2010 @ 9:37:16 AM

ANCHOR QEA integral

0 0.5

Scale in Miles

US EPA's Preliminary Site Boundary

Original (1966) Perimeter of the Northern Impoundments

Area of Groundwater Investigation South of I-10

State Park

Tidal Gauge

* Designation of the sand separation area is intended to be a general reference to areas in which such activities are believed to have taken place based on visual observations of aerial photography from 1998 through 2002.

FEATURE SOURCES:
Aerial Imagery: 0.5-meter 2008/2009 DOQQs-
Texas Strategic Mapping Program (StratMap)
Gauge Location: NOAA

Figure 11
Approximate Location of Tidal Gauge
SJRWP Groundwater Study SAP
SJRWP Superfund Site/MIMC and IPC

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APPENDIX A
REVISED DRAFT GROUNDWATER STUDY FIELD SAMPLING PLAN
SAN JACINTO RIVER WASTE PITS SUPERFUND SITE

TABLE OF CONTENTS

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LIST OF ACRONYMS AND ABBREVIATIONS

Anchor QEA	Anchor QEA, LLC
ASTM	American Society for Testing and Materials
COC	chain-of-custody
COPC	chemical of potential concern
DGPS	differential global positioning system
DP	direct push
FL	Field Lead
FSP	Field Sampling Plan
GPS	global positioning system
HASP	Health and Safety Plan
I-10	Interstate Highway 10
Integral	Integral Consulting Inc.
IDW	investigation derived waste
NOAA	National Oceanic and Atmospheric Administration
PPE	personal protection equipment
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance and quality control
QC	quality control
RI/FS	Remedial Investigation and Feasibility Study
Site	San Jacinto River Waste Pits Superfund Site
SJRWP	San Jacinto River Waste Pits
SOP	standard operating procedure
TCEQ	Texas Commission on Environmental Quality
TOC	total organic carbon
UAO	Unilateral Administrative Order
USCS	Unified Soil Classification System
USEPA	U.S. Environmental Protection Agency

1 INTRODUCTION

This Field Sampling Plan (FSP) has been prepared on behalf of the San Jacinto Group for the 2010 Groundwater Study at the San Jacinto River Waste Pits (SJRWP) Superfund Site (the Site)[1]. This FSP was prepared consistent with U.S. Environmental Protection Agency (USEPA) guidance (USEPA 1988, 1992) and as required by the 2009 Unilateral Administrative Order (UAO); (USEPA 2009a). Additional information on the Site history, setting, and a summary of existing data are provided in the Quality Assurance Project Plan (QAPP), to which this FSP is appended and in previous reports (Remedial Investigation/Feasibility Study [RI/FS] Work Plan; Anchor QEA and Integral 2010).

The Site consists of impoundments, built in the mid-1960s for disposal of paper mill wastes, and the surrounding areas containing sediments and soils potentially contaminated with the waste materials that had been disposed of in these impoundments. Two impoundments, together approximately 14 acres in size, are located on a 20-acre parcel immediately north of the I-10 Bridge and on the western bank of the San Jacinto River, in Harris County, Texas (Figure A-1).

USEPA has identified an area south of I-10 to be investigated, based on historical documents and aerial photographs indicating that an additional impoundment was constructed south of I-10, on the peninsula of land directly south of the 20 acre parcel, and also was used as a

[1] In late October 2010 (following initial submission of this draft Groundwater Study SAP for USEPA review), USEPA expressed concerns that historical uses of land to the south of I-10 may have resulted in contamination of soils in that area from the disposal of wastes, similar to those conducted at the northern impoundments (Figure A-1). The CSM and Site history presented in the RI/FS Work Plan do not address historical waste disposal in areas south of Interstate Highway 10 (I-10), or any related releases of hazardous substances, contaminant transport, or exposure pathways.

USEPA is requiring that the investigation include areas south of I-10 and IPC but not MIMC has agreed to perform the investigation in that area. MIMC's position is explained in a letter to USEPA from MIMC's legal counsel dated October 21, 2010. In response to USEPA's demand, and based on subsequent discussions, the revised Draft Groundwater Study SAP, to which this FSP is attached, includes conceptual consideration of this southern impoundment. This consideration of the southern impoundment does not waive the legal position of MIMC as set out in the aforementioned October 21, 2010 letter. A more detailed historical description of the area south of I-10, a related CSM and, if warranted, a proposed groundwater sampling design will be presented on behalf of IPC in an addendum to this SAP (including an FSP addendum as appropriate to the sampling stations and methods that would be required), following a closer review of historical information for this area and verification of potential impacts. As such, unless specifically noted herein, information and discussions in the Groundwater Study SAP and this FSP pertain to the impoundments located north of I-10.

paper mill waste disposal area in the mid-1960s for paper mill waste similar to that disposed of in the two impoundments. A Texas State Department of Health (TSDH) inspection report dated May 6, 1966, indicates that this older impoundment contained a pond approximately 15 to 20 acres in size (TSDH 1966). Figure A-1 shows both the known 1966 perimeter of the impoundments north of I-10 and the potential area of investigation of groundwater south of I-10. A discussion of the perimeter of the impoundment south of I-10 is presented below, and related uncertainties will be addressed in the Groundwater SAP Addendum to be submitted on behalf of IPC.

As described in the SAP, the primary objectives of the work presented in this Groundwater Study SAP are:

- Obtain groundwater chemistry data from the Site
- Assess the potential for Site-related constituents to be transported by groundwater
- Characterize groundwater flow, including horizontal and vertical gradients within the alluvial and upper Beaumont Formation sediments

Secondary objectives include:

- Obtain hydrologic data describing potential groundwater/surface water interactions
- Further characterize and verify Site subsurface conditions, including the presence and thickness of the Beaumont clay unit
- Obtain additional soil data (see Soil Study SAP [Integral 2010] for additional soil investigation information)

1.1 General Description

The objectives of the groundwater study were described in the previous section. The groundwater study work scope is summarized as follows:

- Borehole advancement at three paired locations (6 total borings; one boring completed in the alluvial sediments and one double cased boring completed below the Beaumont Formation in each pair)
- Soil sampling for grain size and total organic carbon (TOC) analyses, and for archiving for potential future analysis for chemicals of potential concern (COPC) at each boring pair from 0 to 5 feet below grade (1 composite sample) and on a 1 foot composite basis

from 5 feet below grade to boring terminus on a 5 foot interval basis (samples from 9-10 feet, 14-15 feet, etc. below grade)

- Temporary monitoring well construction and installation in each boring
- Monitoring well development, purging and collection of Groundwater Study samples for COPCs (see Section 1.5 of the SAP)
- Hydrology data collection from newly installed monitoring wells and from an established stream gage on the San Jacinto River
- Data evaluation, synthesis and reporting (within the pending Preliminary Site Characterization Report)
- Monitoring well abandonment immediately following sampling consistent with Texas guidance (State of Texas 2010a). Required because of planned removal action construction activities.

1.2 Project Organization

MIMC and IPC have retained Anchor QEA, LLC and Integral Consulting, Inc. to perform the FSP and provide database administration and analytical laboratory coordination. The primary contacts for each organization, including USEPA oversight are provided in the following tables:

Title	Name	Contact Information
USEPA	Stephen Tzhone	U.S. Environmental Protection Agency, Region 6 1445 Ross Avenue Dallas, TX 75202-2773 (214) 665-8409 tzhone.stephen@epa.gov
McGinnes Industrial Maintenance Corporation Project Manager	Andrew Shafer	McGinnes Industrial Maintenance Corp. 9590 Clay Road Houston, TX 77080 (713) 772-9100 Ext. 109 dshafer@wm.com
International Paper Company Project Manager	Philip Slowiak	International Paper Company 6400 Poplar Avenue Memphis, TN 38197-0001 (901) 419-3845 philip.slowiak@ipaper.com

The names and quality assurance (QA) responsibilities of key project personnel for Anchor QEA and Integral are provided below:

FSP Personnel Quality Assurance Responsibilities

Title	Responsibility	Name	Contact Information
Project Coordinator	Coordination of project information and related communications on behalf of IPC and MIMC	David Keith	Anchor QEA, LLC 614 Magnolia Avenue Ocean Springs, MS 39564 (228) 818-9626 dkeith@anchorqea.com
Anchor QEA Corporate Health and Safety Manager	Oversight of health and safety program for field tasks associated with RI/FS	David Templeton	Anchor QEA, LLC 1423 Third Avenue Suite 300 Seattle, WA 98101 (206) 287-9130 dtempleton@anchorqea.com
Field Lead Anchor QEA	Field data collection and implementation of the Health and Safety Plan in the field	Chris Torell	Anchor QEA, LLC 290 Elwood Davis Road Liverpool, NY 13088 (315) 453 9009 ctorell@anchorqea.com
Project Database Administrator Integral	Database development and data management	Dreas Nielson	Integral Consulting Inc. 411 First Avenue South Suite 550 Seattle, WA 98104 (206) 957-0351 dnielson@integral-corp.com
Project Laboratory QA Coordinator Integral	Completeness of QA documentation and procedures	Craig Hutchings	Integral Consulting Inc. 1205 West Bay Drive NW Olympia, WA 98502 (360) 705-3534 chutchings@integral-corp.com

1.3 Laboratories

The following responsibilities apply to the project manager and QA (quality assurance) manager at the analytical laboratories used for this study.

The laboratory project manager is responsible for the successful and timely completion of sample analyses, and for performing the following tasks:

- Ensure that samples are received and logged in correctly, that the correct methods and modifications are used, and that data are reported within specified turnaround times.
- Review analytical data to ensure that procedures were followed as required in the FSP, the cited methods, and laboratory standard operating procedures (SOPs).
- Keep the task QA coordinator apprised of the schedule and status of sample analyses and data package preparation.
- Notify the task QA coordinator if problems occur in sample receiving, analysis, or scheduling, or if control limits cannot be met.
- Take appropriate corrective action as necessary.
- Report data and supporting QA information as specified in this FSP.

The laboratory QA manager is responsible for overseeing the QA activities in the laboratory and ensuring the quality of the data for this project. Specific responsibilities include the following:

- Oversee and implement the laboratory's QA program.
- Maintain QA records for each laboratory production unit.
- Ensure that QA and quality control (QC) procedures are implemented as required for each method and provide oversight of QA/QC practices and procedures.
- Review and address or approve nonconformity and corrective action reports.

Coordinate response to any QC issues that affect this project with the laboratory project manager.

1.4 Document Organization

This FSP describes the project organization and field methods that will be used to conduct the groundwater investigation. In conjunction with the SAP, the procedures in Sections 2 through 4 of this FSP will guide the field staff during completion of the investigation tasks. Section 2 of this FSP describes the monitoring well installation and sampling procedures.

Section 3 summarizes field documentation and chain-of-custody (COC) procedures. Field data reporting and sample chain of custody procedures are discussed in Section 4.

The following documents are provided as attachments to this FSP:

- Standard Operating Procedures (SOPs). The SOPs are provided in Attachment A-1. These include the SOPs developed by Integral for equipment decontamination, sample handling, and chain-of-custody. Anchor QEA will use the Integral procedures during the groundwater investigation to be consistent with the procedures used during the sediment and soil investigations. Also provided are the USEPA's low-flow groundwater sampling protocols, ASTM's soil logging standards, and GeoProbe's® field procedures. The USEPA, ASTM, and GeoProbe® procedures are provided as a supplement to the FSP and many of the procedures in these guidelines are not Site specific, and therefore, are to be considered secondary to the procedures specified in this FSP.
- Field Forms. Attachment A-2 contains examples of various forms that will be used during field sampling.

2007) and at the Texarkana Wood Preserving site (USEPA 2010a). Regarding groundwater sampling, sampling from wells installed using DP techniques result in statistically similar results relative to paired standard monitoring wells installed by conventional drilling methods (GeoProbe® 2010).

2.2.1.2 Field Equipment and Supplies

Field equipment and supplies include sampling equipment, utensils, decontamination supplies, sample containers, coolers, shipping containers, log books and forms, personal protection equipment (PPE), and personal gear. In support of groundwater sampling efforts, clean tubing, pumps and a water quality monitor with a flow-through cell will be used. PPE is required to minimize the potential for unacceptable exposure to COPCs and the possibility of cross-contamination of samples during all sampling activities. Additional information on protective wear required for this project is provided in the HASP.

Sample jars, preservatives, distilled/deionized water, coolers, and packaging material for the samples, will be supplied by the analytical laboratory. Commercially available, pre-cleaned jars will be used for the samples, and the testing laboratories will maintain a record of certification from the suppliers. Details on the numbers and type of sample containers are provided in the SAP and in Table A-2 of this FSP. The Field Lead (FL) and field personnel in charge of sample handling in the field will use a sample matrix table (Table A-1) as a QC check to ensure that all samples have been collected at a given station. This table includes the total number and type of sample jars required for each analysis at each sampling station.

Sample containers will be clearly labeled at the time of sampling. Labels will include the task name, sample location and number, sampler's initials, analyses to be performed, and sample date and time. Sample numbering and identification procedures are described in detail in Sections 3.5 and 3.6.

2.2.2 Sample Location Positioning

Sample location positioning will be accomplished a using hand-held Global Positioning Unit (GPS) to locate the approximate sampling location, followed by post-work survey using Digital GPS (DGPS) or standard survey techniques.

Accuracy for pre-work positioning will be +/- 2 m horizontal. Anticipated sampling location coordinates are provided in Table 3 of the SAP. If field conditions permit, actual sample locations should fall within a 5 foot radius of the planned positions. Hand-held GPS operation will follow the unit's instructions.

Post-work survey (sample locations, well riser elevations, etc.) will have a requisite accuracy of +/- 0.1 foot horizontal and +/- 0.01 foot vertical. The standard projection method to be used during field activities is Horizontal Datum: NAD1983_StatePlane, Texas South Central, FIPS 4204, US feet. All post-work survey activities will be conducted by a Texas-licensed professional surveyor using TAC procedures, and relative to the Harris County Subsidence District benchmark HGCSD 33 (26.57 feet NAVD88 – TSARP) previously used at the Site.

2.2.3 Borehole Advancement and Soil Sample Collection

Soil borings will be advanced at each well pair location using DP techniques. The tooling size used will be 3.5 inch outside diameter dual tube, commensurate with the eventual monitoring well size (anticipated to be 1.5-inch inside diameter, prepacked well assemblies). Soil samples will be collected continuously in the deep boring at each pair. Redundant soil samples will not be retained from the shallow, adjacent boring in each pair. The soil sample collection method will be similar to GeoProbe's® sampling procedure DT325 (Attachment A-1), which describes continuous, dual tube core barrel soil sampling[2]. The deep boring in each pair will be conducted first, which will enable precise termination of the shallow boring, and proper well screen placement (see below) above the Beaumont Formation clay.

The deep soil borings will include an outer casing that is driven approximately 5 feet into the Beaumont Formation clay (anticipated at approximately 30 feet below ground surface at the Site) to limit downward migration of groundwater. Once the outer casing is set, drilling will continue until the borehole advances approximately 10 feet beyond the lower extent of the Beaumont Formation clay (anticipated to be approximately 60 feet below ground surface at the Site).

[2] Depending on subcontracting results, a non-GeoProbe® contactor may be selected. In that event, equivalent procedures will be used.

Soil samples will be collected using standard dual tube direct push sampling methods. Samples will be composited from over the 0 to 5 foot interval (1 sample) and as 1 foot composites every 5 feet thereafter (9-10 feet, 14-15 feet, etc.). The field geologist will log each core in accordance with ATSM D 2488 *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)* in Attachment A-1 and the using the boring log form in Attachment A-2. Samples will be collected on a composite basis as shown on Table A-1. The Soil Study SAP (Integral 2010) provides additional information regarding soil sampling and analyses.

As practicable, during sample processing, soil touching the sides of the sampler will be excluded from each sample. Composites will be created by obtaining equal parts from the full interval, within the interior of the soil sample length (i.e., excluding soil touching the sides of the sampler). The sample interval will be homogenized with a decontaminated stainless-steel mixing implement (e.g., spoon) until the soil attains a visually uniform color and texture. Subsamples will then be removed for the various kinds of laboratory analyses and for archiving. See Section 2.5 for excess material handling procedures.

The soil composite samples will be placed in labeled, laboratory-cleaned sample containers with Teflon-lined lids (Table A-2). Each sample container will be clearly labeled with the task name, sample number, type of analysis to be performed, date and time, and initials of person(s) preparing the sample. Containers that will be frozen (i.e., archived samples) will have an approximate 1 inch headspace above the sample to prevent the jars from breaking during storage at the laboratory. Immediately after sample containers are filled, the samples will be stored on ice (4±2°C).

As stated above, the sample matrix table (Table A-1) shows the total number of sample jars for each analysis needed at each sampling station. Field personnel in charge of sample handling will use this table as a QC check to ensure that all samples at a given station are collected and that the appropriate sample container is used for each sample. Note that the total number of soil samples will depend upon the final depth of the boring, so extra soil sample jars should be stored at the Site in case the borings have to be deeper than is indicated on Table A-1.

2.2.4 Monitoring Well Installation

Upon completion of each boring, 1.5 inch monitoring wells with pre-packed well screens will be installed in the borehole through the existing downhole tooling. Wells will be installed using methods similar to GeoProbe's® Technical Bulletin 992500 (Attachment A-1) and consistent with USEPA's *Groundwater Sampling and Monitoring with Direct Push Technologies* (USEPA 540/R-04/005 August 2005a). Some variations to the SOPs may be necessary to account for Site specific subsurface conditions or to accommodate the drilling equipment being used on this project.

Shallow wells will be screened above the Beaumont Formation clay (anticipated approximately 30 feet below ground surface) and below fill material. As field conditions permit, shallow wells will have a 5 foot screen placed equidistant between fill material and the Beaumont Formation clay. Deep wells will have a 10 foot screen placed just below the lower extent of the Beaumont Formation clay (anticipated approximately 60 feet below ground surface).

Monitoring wells will be constructed of 1.5 inch inside diameter, flush threaded, Schedule 40 polyvinyl chloride (PVC) riser and 1.5 inch inside diameter, 2.5 inch outside diameter, pre-packed well screens. Each well screen will consist of a 5 foot long, 0.01 inch slotted screen, encircled along its full length by 20/40 mesh silica sand, held in place by stainless steel wire mesh with a 0.011 inch pore size. 5 foot screen sections can be combined to result in longer screen lengths.

Following placement of the well assembly through the dual tube rods already in place, an approximate 2 foot thick grout barrier of 20/40 mesh silica sand will be emplaced above the screened section inside the rod string. An approximate 4 foot thick bentonite slurry will be tremied into the well annulus above the grout barrier to form the seal. The remainder of the annulus to within approximately 1.5 feet of grade will be filled with a bentonite slurry. The remainder of the annulus will be filled with bentonite/cement to allow placement of the protective well cover. During these well construction procedures, probe rods will be removed as materials (sand, bentonite, etc.) are placed into the annulus. Each well will be finished with a well cover and concrete pad and protected from damage by perimeter bollards, as needed, and until abandonment.

Well construction details, consisting of materials, materials length/thickness and approximate depth below grade will be recorded in the field log book and transferred to well construction forms (Attachment A-2).

2.2.5 Monitoring Well Development

Monitoring wells will be developed consistent with USEPA's *Low Stress (low flow) Purging and Sampling Procedure for the collection of Groundwater Samples from Monitoring Wells* (USEPA 1996) and applicable TCEQ guidance following installation and after an appropriate time period for the well seal and grout to cure. Well development will be conducted, to restore original subsurface conditions around the screened interval, to the extent practicable, and facilitate collection of representative and defensible groundwater samples.

Depending on sequencing of field tasks, development may be conducted using GeoProbe® equipment already on Site or during a separate mobilization. It is currently anticipated that development will be conducted using the GeoProbe® equipment.

Development will be accomplished using a downhole bladder pump or peristaltic pump and clean tubing assembly. Surge blocks will be used during development to assist in with the in removing fine grained materials from the well screen and filter pack. Attachment A-1 includes the SOP for using a GeoProbe® mechanical bladder pump assembly and operation.

Once well materials have cured, the water level in the well will be calculated to determine well volume (amount of water inside the well screen and riser). The length of screened interval below ground surface will be determined based on the boring log. The tubing and pump assembly, including surge block, will be placed in the well with the intake of the tubing approximately in the middle of the screened interval. The outflow end of the tubing will be connected to a water quality meter with a flow-through monitoring cell.

Development will be conducted by manually pushing the surge block up and down through the screen zone. Following use of the surge block, the peristaltic pump or bladder pump will be lowered into the well to remove the silty groundwater. This process will be continued until turbidity levels are reduced to an acceptable level. Occasionally, the peristaltic or bladder pump intake will be lowered and raised throughout the full screened interval to surge the screen. Field parameters (turbidity, dissolved oxygen, specific conductance, temperature, pH and oxidation/reduction potential [ORP]) will be measured using the water quality meter every 3 to 5 minutes. The goal of development will be to stabilize these water quality parameters to +/- 10% between readings, indicating representative groundwater is being drawn into the well. Well development should continue until the turbidity levels are as low as reasonably feasible and continued development does not result in significant reduction in turbidity.

2.2.6 Monitoring Well Sampling

Monitoring wells will be sampled for primary and secondary COPCs following development activities. If sampling occurs immediately following development, (currently anticipated), no well purging will be necessary. In the event sampling occurs after a period following development (i.e., more than several hours), the well will be purged using the sampling equipment to ensure representative water enters the well for sampling.

Sampling will be conducted using methods consistent with the intent of USEPA's *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells* (Attachment A-1; USEPA 1996) and consistent with the intent of TCEQ guidance (*Sample Handling and Preservation Procedures and the Collection Procedures for Groundwater Samples [TCEQ 2003),* and *Groundwater Sampling – Filtering, Low Flow Purging* [TCEQ 1998]).

Low flow sampling techniques will be used to sample groundwater. Groundwater will be removed from the well at approximately 0.1 liters per minute using the mechanical bladder pump or peristaltic pump configuration described previously. Samples will be collected prior to the flow-through cell used to monitor water quality parameters. Consistent with guidance, the discharge tubing should be completely filled at the time of sampling to avoid loss of volatile organic compounds. Water quality data (turbidity, dissolved oxygen, specific conductance, temperature, and pH) will also be recorded at the time of bottle filling. Table A-1 lists the groundwater sample analyses. The groundwater samples will be placed in labeled, laboratory-cleaned sample containers (Table A-2). Each sample container will be clearly labeled with the task name, sample number, type of analysis to be performed, date and time, and initials of person(s) preparing the sample. Immediately after sample containers are filled, the samples will be stored on ice (4±2°C).

Field personnel in charge of sample handling will use this table as a QC check to ensure that all samples at a given station are collected and that the appropriate sample container is used for each sample.

2.2.7 Water Level Monitoring

Water level monitoring will consist of manual measurement of static water level elevations in monitoring wells and obtaining San Jacinto River gage readings (via download) from the fixed tidal gage at San Jacinto Battleground State Park (NOAA Station 8770743; Figure 11 of the SAP). The tidal gage selection may be modified, depending on the timing of Fate and Transport Study activities, which include installation and monitoring of a temporary tidal gage.

Water level data will be collected during field activities (i.e., during well installation, development/purging and sampling) using a standard, electronic water level probe. Care will be taken to determine if static water levels are present in the well at the time of monitoring. This will be accomplished by monitoring wells after a period of approximately 24 hours following completion of any activity involving water removal, to ensure static conditions exist. Recent precipitation will also be considered when obtaining water level data.

Water level monitoring will be conducted consistent with Water Level Measurement; SOP No. 2043, (USEPA 1994). Appendix A-2 contains a water level monitoring form.

2.2.8 Equipment Decontamination

Before sampling begins at a location, all reusable sampling equipment that will contact sampling media will be scrubbed with a standard detergent (e.g., Alconox® or Liquinox®), rinsed with ethanol and hexane and air-dried. Equipment used for compositing the soil samples (i.e., stainless-steel bowls and spoons) will follow the same decontamination sequence, except that the final rinse with laboratory-grade distilled/deionized water will be used. After cleaning, the decontaminated sample homogenizing equipment will be covered with aluminum foil to protect it from possible contamination.

Dedicated sampling equipment and supplies (i.e., new water discharge tubing, new core liners) will not require decontamination. However, such materials that have been subject to potential contamination through broken seals, damaged wrapping, or similar conditions will not be used and will be discarded.

Large equipment (i.e., drilling rods or core barrels) will be decontaminated using a steam cleaner or the decontamination wash procedure described above.

SOP SD-01 (Attachment A-1) provides the decontamination procedure used for sediment sampling equipment. This procedure will also be used for soil and groundwater sampling equipment, as amended above in this section.

2.3 Field Quality Control Samples

Field QC samples will be used to assess sample variability and evaluate potential sources of contamination. The types of QC samples that will be collected for the 2010 Groundwater Study are described in this section. Detailed information on quality assurance and quality control (QA/QC) procedures, limits, and reporting is provided in the SAP. The estimated number of field QC samples to be collected is listed in the sample matrix table (Table A-1). If QC problems are encountered, they will be brought to the attention of the QA coordinator. Corrective actions, if appropriate, will be implemented to meet the task's data quality indicators.

Field QC samples will include field split samples, equipment filter wipe blanks, filter blanks, and standard reference materials (SRM). The following QC samples will be collected in the field and analyzed by the analytical laboratory:

- Field split samples will be collected and analyzed to assess the variability associated with sample processing and laboratory variability. Blind field split samples will be collected at a minimum frequency of 1 field split sample per 20 sampling stations. Samples will be assigned unique numbers and will not be identified as field splits to the laboratory. Field split samples will be collected for groundwater and soil samples for chemical analysis (see Soil Study SAP for additional soil sample-related information).

- A minimum of one field equipment filter wipe will be collected for each kind of sampling equipment used for chemical analyses. One equipment wipe will be prepared for each analysis type. If multiple analyses are requested, separate sets of filter wipes will be collected for each analysis type, for each kind of sampling equipment used, as the equipment can be wiped down only once for each piece of filter paper. This ensures that the filter wipe result represents the most conservative estimate of potential cross contamination for each analysis type. (Note: Filter papers must be stored in their original box, wrapped carefully in three layers of aluminum foil, or contained in a glass jar. The filter paper box cannot be stored in plastic bags or containers.)
- Filter blanks are prepared in the field to evaluate potential background concentrations present in filter paper used for the equipment filter wipe blank. Filter blanks will be collected at a minimum frequency of one for each lot number of filter papers used for collecting the equipment wipe blanks.
- Standard reference materials are samples of known concentration that have typically undergone multi-laboratory analyses using a standard method. Reference materials provide a measure of analytical performance and/or analytical method bias. Where available, standard reference materials will be submitted from the field at a frequency of once per sampling event.

2.4 Sample Handling, Packaging, Transport and Custody

Sample coolers and packing materials will be supplied by the analytical laboratories. For shipment with filled containers, individual sample jars will be labeled and placed into plastic bags and sealed. Samples will then be packed in a cooler lined with a large plastic bag. Glass jars will be packed to prevent breakage and separated in the cooler by bubble wrap or other shock-absorbent material. Ice in sealed plastic bags will then be placed in the cooler to maintain a temperature of approximately 4°C (±2°C). When the cooler is full the COC form will be placed into a zip-locked bag and taped to the inside lid of the cooler. A temperature blank will be added to each cooler. Each cooler will be sealed with two COC seals, one each on the front and side of the cooler. Labels indicating "This End Up" with an arrow and "Fragile" will be attached to each cooler.

The shipping containers will be clearly labeled (i.e., name of task, time and date container was sealed, person sealing the cooler, and company name and address) for positive identification. These packaging and shipping procedures are in accordance with U.S. Department of Transportation regulations (49 CFR 173.6 and 49 CFR 173.24). Coolers containing samples for chemical analyses will be transported to the laboratory by courier or overnight shipping service.

After the samples have been received by the laboratory, they will be stored under refrigeration (4±2°C). Soil samples designated for archival will be stored frozen at –20°C (Table A-2).

2.5 Investigation Derived Wastes

Solid and liquid investigation derived waste (IDW) from well drilling, well purging, and well sampling procedures, will be containerized and temporarily stored on-site. The materials will then be characterized and properly disposed off-site at a licensed disposal facility. The subcontractor will be required to have, at a minimum, a drum management service that provides the following:

- Proper waste identification including full analytical capability
- Pick up and disposal services
- Safe and proper transportation
- Environmentally sound treatment and disposal
- Regularly scheduled service visits with manifest and label preparation.

All disposable materials used for sample collection and processing, such as paper towels and gloves, will be placed in heavyweight garbage bags or other appropriate containers. Disposable supplies that do not contain Site soils or water will be removed from the Site by sampling personnel and placed in a normal refuse container for disposal at a solid waste landfill.

3 FIELD DOCUMENTATION

The integrity of each sample from the time of collection to the point of data reporting must be maintained. Proper record-keeping and COC procedures will allow samples to be traced from collection to final disposition. Representative photographs will be taken at each sampling location, of each soil sample and of well development and sampling activities. Site photos from various angles and close-up views of the overall conditions will also be collected.

3.1 Field Log Book

Field activities and observations will be noted in a log book. The field log book will be a bound document and may contain individual field and sample log forms (depending on the sampling activity). Information will include personnel, date, time, station designation, sampler, types of samples collected, and general observations. Changes that occur during sampling (e.g., personnel, responsibilities, or deviations from the FSP) and the reasons for these changes will be documented. The log book will identify on-site visitors (if any) and the number of photographs taken at each sampling location. Each FL is responsible for ensuring that their respective field log book and field data forms are correct. Requirements for log book entries will include the following:

- Log books will be bound, with consecutively numbered pages.
- Removal of any pages, even if illegible, will be prohibited.
- Entries will be made legibly with black (or dark) waterproof ink.
- Unbiased, accurate language will be used.
- Entries will be made while activities are in progress or as soon afterward as possible (the date and time that the notation is made should be recorded, as well as the time of the observation itself).
- The consecutive day's first entry will be made on a new, blank page.
- The date and time, based on a 24-hour clock (e.g., 0900 a.m. for 9:00 a.m. and 2100 for 9:00 p.m.), should appear on each page.

In addition to the preceding requirements, the person recording the information must initial and date each page of the field log book. If more than one individual makes entries on the same page, each recorder must initial and date each entry. The bottom of the page must be signed and dated by the individual who makes the last entry.

Log book corrections will be made by drawing a single line through the original entry, allowing the original entry to be read. The corrected entry will be written alongside the original. Corrections will be initialed and dated and may require a footnote for explanation.

The type of information that may be included in the field log book and/or field data forms includes the following:

- Task name, task location, and task number
- Task start date and end date
- A record of Site health and safety meetings, updates, and related monitoring
- Weather conditions
- Name of person making entries and other field staff
- On-site visitors, if any
- Sampling vehicle
- Station name and location
- Date and collection time of each sample
- The sample number for each sample to be submitted for laboratory analysis
- The sampling location name, date, gear, and sampling location coordinates derived from GPS
- Specific information on each type of sampling activity
- The sample number, date and time of collection, equipment type, and the lot number for the box of filter papers used for field QC samples
- Observations made during sample collection, including weather conditions, complications, and other details associated with the sampling effort
- Sample description (source and appearance, such as soil type, color, presence of anthropogenic material, and presence and type of biological structures, other debris, oil sheens, and odor)
- Sampling intervals
- Visible debris near any of the sampling locations
- Surface vegetation that is removed from the sampling location prior to sampling
- The locations of surface water runoff or seeps that are located near the sampling

stations

- The number of photographs taken at the sampling location
- Deviations from the FSP and reasons for deviation

In addition, a sampling location map will be updated during sampling and will be maintained throughout the sampling event. Log books must be completed at the time that any observations are made. Copies of log books and forms will be retained by the technical team.

3.2 Boring Logs

The field geologist will record field conditions and sampling notes on a standard boring log/well construction diagram (Attachment A-2). Logs will include the following information:

- Date and time of collection of each sample interval
- Names of field personnel collecting and handling the samples
- Type of sampling equipment used (e.g., direct push)
- Observations made during sample collection, including weather conditions, complications, and other details associated with the sampling effort
- The sample station identification
- Length and depth intervals of each sample section and estimated recovery
- Qualitative notation of apparent resistance during driving
- Physical soil description in accordance with the USCS (includes soil type, moisture, density/consistency of soil, and color)
- Odor (e.g., hydrogen sulfide, or petroleum)
- Visual stratification, structure, and texture
- Vegetation
- Debris (e.g., woodchips or fibers, concrete, or metal debris)
- Evidence of biological activity (e.g., detritus, shells, tubes, bioturbation, or live or dead organisms)
- Presence of oil sheen
- Well construction details
- Deviations from the approved FSP

3.3 Well Development/Groundwater Sampling Logs

Activities conducted during well development and sampling efforts will be recorded on appropriate log forms (Attachment A-2). The following information will be included:

- Date, time and duration of development/sampling
- Names of field personnel collecting and handling the samples
- Type of sampling equipment used (e.g., bladder or peristaltic pump and tubing)
- Observations made during sample collection, including weather conditions, complications, and other details associated with the sampling effort
- The sample station identification
- Water level data and estimate volume of water in well
- Field parameters collected during activity, along with time an approximate flow rate
- Incremental and total estimated volumes of well water removed
- Physical water description (e.g., cloudy, clear, odor)
- Presence of oil sheen
- Any deviation from the approved FSP

3.4 Chain-of-Custody Procedures

Samples are in custody if they are in the custodian's view, stored in a secure place with restricted access, or placed in a container secured with custody seals (see SOP AP-03 in Attachment A-1). A COC record will be signed by each person who has custody of the samples and will accompany the samples at all times. COC forms will be preprinted by the laboratory and shipped with sample coolers. Completed COC forms will be included in laboratory and QA/QC reports.

At a minimum, the form will include the following information:

- Site name
- FL's name and team members responsible for collection of the listed samples
- Collection date and time for each sample
- Sample type (i.e., sample for immediate analysis or archive)
- Number of sample containers shipped
- Requested analyses
- Sample preservation information (if any)

- Name of the carrier relinquishing the samples to the transporter, noting date and time of transfer and the designated sample custodian at the receiving facility

The FL (or delegate) will be the designated field sample custodian and will be responsible for sample tracking and COC procedures for the samples. The field sample custodian will be responsible for final sample inventory and will maintain sample custody documentation. The field sample custodian will complete COC forms prior to removing samples from the field. Upon transferring samples to the laboratory sample custodian (if a local laboratory is selected) or shipping courier (as appropriate), the field sample custodian will sign, date, and note the time of transfer, on the COC form. The original COC form will be transported with the samples to the laboratories. Samples will be shipped to the testing laboratories in either coolers or shipping containers sealed with custody seals.

Each laboratory will designate a sample custodian who will be responsible for receiving samples and documenting their progress through the laboratory analytical process. The sample custodian for each laboratory will establish the integrity of the custody seals upon sample arrival at the laboratory. The laboratory sample custodian will also ensure that the COC and sample tracking forms are properly completed, signed, and initialed upon receipt of the samples.

When the laboratory receives the samples, the laboratory sample custodian will conduct an inventory by comparing sample labels to those on the COC document. The custodian will enter the sample number into a laboratory tracking system by task code and sample designation. The custodian will assign a unique laboratory number to each sample and will be responsible for distributing the samples to the appropriate analyst or for storing samples at the correct temperature in an appropriate secure area.

3.5 Station Numbering

Sample stations will be assigned a unique identification code based on a designation scheme designed to suit the needs of the field personnel, data management, and data users. Station numbers will include "SJ" to indicate San Jacinto followed by a two-letter code for the type of sample to be collected at a given location (MW = monitoring well). The letters will be followed by a three-digit alpha-numeric indicator (e.g., S01, D02, or S03). An example station number for the 2010 Groundwater Study is SJMWD01, indicating the deep monitoring well at location 1.

Station numbers will not be recorded on sample labels or COC forms to prevent analytical laboratories from seeing the relationships between samples and stations.

3.6 Sample Identifiers

Each sample from a given station will also have a unique label identifier. Sample identifiers will be established before field sampling begins and assigned to each sample as it is collected. Sample identifiers consist of codes designed to fulfill three purposes: 1) to identify related samples (i.e., field split samples) to ensure proper data analysis and interpretation; 2) to obscure the relationships between samples so that laboratory analysis will be unbiased by presumptive similarities between samples; and 3) to track individual sample containers to ensure that the laboratory receives all of the material associated with a single sample. To accomplish these purposes, each container is assigned a sample number and a tag number. These codes and their uses are described below:

- A sample identifier for each sample will be created as follows: the station number (e.g., SJMWD01), followed by a code for the kind of sample collected at a given location (S = soil, W = groundwater). In addition, each sample will have a sample number of 4 final numbers that will distinguish between the different sample intervals (e.g., 0005 = 0 to 5 feet, 0510 = 5 to 10 feet, etc.) Water samples will have the final number identifier 0000.
- All subsamples of a composited field sample will have the same sample number. Each field split sample will have a different sample number, and the sample numbers of related field QC samples may not share any content. The sample number appears on the sample containers and the COC forms.
- A unique numeric sample tag number will be attached to each sample container. If the amount of material (i.e., everything associated with a single sample number) is too large for a single container, each container will have the same sample number and a different sample label with a unique sample tag number. A sample will also be split between containers if a different preservation technique is used for each container

(i.e., because different analyses will be conducted). The sample tag number will appear on the COC forms. Tag numbers are used by laboratories only to confirm that they have received all of the containers that were filled and shipped. Data are reported by sample number.

Sample numbers will be assigned sequentially in the field, and sample labels will be preprinted with tag numbers.

For equipment filter wipe blanks, sequential numbers starting at 900 will be assigned instead of station numbers. For example, the first filter wipe blank for a soil sample collected with a stainless steel spoon and stainless steel bowl will be labeled as SOFW-901S, whereas the second filter wipe blank for a groundwater sample collected with a bladder pump will be labeled as GWFW-902B (GW = groundwater, FW = filter wipe, S = stainless steel spoon and bowl, and B = bladder pump).

4 FIELD DATA MANAGEMENT AND REPORTING PROCEDURES

During field operations, effective data management is critical to providing consistent, accurate, and defensible data and data products. Daily field records (a combination of field log books, field forms, if any, and COC forms) will make up the main documentation for field activities. Upon completion of sampling, field notes, data sheets (if any), and COC forms will be scanned to create an electronic record. Field data will be manually entered into the project database. One hundred percent of the transferred data will be verified based on hard copy records. Electronic QA checks to identify anomalous values will also be conducted following entry.

Additional discussion of field data management is provided in the SAP.

5 REFERENCES

See Groundwater Study SAP for references.

TABLES

Table A-1
Sample Collection Matrix - Northern Impoundments
Groundwater Study SAP
San Jacinto River Waste Pits Superfund Site

Station ID	Station Coordinates	Sample ID[1]	Sample Matrix	Composited Depth Interval Below Ground Surface (ft)	Archive	Primary COPCs[2]			Secondary COPCs[2]		Geotechnical/Conventional	
						Dioxins/Furans	Metals	SVOCs	PCBs	SVOCs	Grain Size	TOC
SJMWS01		SJMWS01-W0000	Groundwater	--	no	x	x	x	x	x	--	--
SJMWD01		SJMWD01-S0005	Soil	0-5	yes except geotechnical/conventional	x	x	x	x	x	x	x
SJMWD01		SJMWD01-S0910	Soil	9-10	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD01		SJMWD01-S1415	Soil	14-15	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD01		SJMWD01-S1920	Soil	19-20	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD01		SJMWD01-S2425	Soil	24-25	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD01	3216664 E 13857374 N	SJMWD01-S2930	Soil	29-30	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD01		SJMWD01-S3435	Soil	34-35	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD01		SJMWD01-S3940	Soil	39-40	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD01		SJMWD01-S4445	Soil	44-45	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD01		SJMWD01-S4950	Soil	49-50	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD01		SJMWD01-S5455	Soil	54-55	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD01		SJMWD01-S5960	Soil	59-60	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD01		SJMWD01-S6465	Soil	64-65	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD01		SJMWD01-S6970	Soil	69-70	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD01		SJMWD01-W0000	Groundwater	--	no	x	x	x	x	x	--	--
SJMWS02		SJMWS01-W0000	Groundwater	--	no	x	x	x	x	x	--	--
SJMWD02		SJMWD01-S0005	Soil	0-5	yes except geotechnical/conventional	x	x	x	x	x	x	x
SJMWD02		SJMWD01-S0910	Soil	9-10	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD02		SJMWD01-S1415	Soil	14-15	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD02		SJMWD01-S1920	Soil	19-20	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD02		SJMWD01-S2425	Soil	24-25	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD02	3217053 E 13857791 N	SJMWD01-S2930	Soil	29-30	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD02		SJMWD01-S3435	Soil	34-35	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD02		SJMWD01-S3940	Soil	39-40	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD02		SJMWD01-S4445	Soil	44-45	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD02		SJMWD01-S4950	Soil	49-50	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD02		SJMWD01-S5455	Soil	54-55	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD02		SJMWD01-S5960	Soil	59-60	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD02		SJMWD01-S6465	Soil	64-65	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD02		SJMWD01-S6970	Soil	69-70	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD02		SJMWD01-W0000	Groundwater	--	no	x	x	x	x	x	--	--
SJMWS03		SJMWS01-W0000	Groundwater	--	no	x	x	x	x	x	--	--
SJMWD03		SJMWD01-S0005	Soil	0-5	yes except geotechnical/conventional	x	x	x	x	x	x	x
SJMWD03		SJMWD01-S0910	Soil	9-10	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD03		SJMWD01-S1415	Soil	14-15	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD03		SJMWD01-S1920	Soil	19-20	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD03		SJMWD01-S2425	Soil	24-25	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD03	3217206 E 13857112 N	SJMWD01-S2930	Soil	29-30	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD03		SJMWD01-S3435	Soil	34-35	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD03		SJMWD01-S3940	Soil	39-40	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD03		SJMWD01-S4445	Soil	44-45	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD03		SJMWD01-S4950	Soil	49-50	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD03		SJMWD01-S5455	Soil	54-55	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD03		SJMWD01-S5960	Soil	59-60	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD03		SJMWD01-S6465	Soil	64-65	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD03		SJMWD01-S6970	Soil	69-70	yes except geotechnical/conventional	x	x	x	--	--	x	x
SJMWD03		SJMWD01-W0000	Groundwater	--	no	x	x	x	x	x	--	--
Field Quality Assurance / Quality Control Samples[3]												
SJ#####		SJ#####-D#	Soil	TBD	yes	x	x	x	x	x	--	--
SJ#####		SJ#####-D#	Groundwater	--	no	x	x	x	x	x	--	--
SJ#####	--	SOFW-90##	Soil Sampling Equipment	TBD	yes	x	x	x	x	x	--	--
SJ#####		MWFW-90##	Groundwater Sampling Equipment	--	no	x	x	x	x	x	--	--
SJ#####		SJ#####-FB#	--	--	no	x	x	x	x	x	--	--
SRM		SRM-904	--	--	no	x	--	--	--	--	--	--

Notes:

1 Each soil sample ID will include a depth identifier as follows: SJMWS01-S0005 which indicates the sample was collected from 0 to 5 feet below ground surface. SJMW01S01-S1011 which indicates the sample was collected from 10 to 11 feet below ground surface. SJMW01S-W0000 indicates a groundwater sample. See FSP for detailed sample indentification procedures.

2 See Table 2 and Section 1.5 of the SAP for additional information regarding COPC selection.

3 Key - "D" = Field Duplicate (freq. 1/20),"FW" = Filter Wipe (freq. 1/20), "FB" = Filter Blank (freq. 1 per box filters), "SRM" = Standard Reference Material (freq. 1 per sampling effort)

Sample intervals may be adjusted based on field conditions, particularly with regard to lithology and potential confining units. Sample intervals will be collected generally from 0-5 feet and in 1 foot intervals there after (i.e., 10-11 feet, 15-16 feet). QA/QC sample numbers will be adjusted accordingly.

TBD - To be determined

SRM - Standard Reference Material

Table A-2
Sample Containers, Preservation, and Holding Time Requirements
Groundwater Study SAP
San Jacinto River Waste Pits Superfund Site

Matrix	Container [a] Type	Size	Laboratory	Parameter	Preservation	Holding Time	Sample Size [b]
Water (groundwater)							
	HDPE	500 mL	TBD	Metals (total and dissolved)	4±2°C, HNO_3 to pH<2	6 months	100 mL
	HDPE	500 mL	TBD	Mercury	4±2°C, HNO_3 to pH<2	28 days	100 mL
	AG	1L	TBD	Dioxins/furans	4±2°C	1 year/1 year [e]	1L
	AG	1L	TBD	Semivolatile organic compound	4±2°C	14 days	500 mL
	AG	1L	TBD	PCBs	4±2°C	14 days	500 mL
Soil [g]							
	WMG	8 oz.	TBD	TOC	4±2°C/ Deep frozen (-20°C)	6 months	10 g
	WMG	16 oz.	TBD	Grain size	4±2°C	6 months	500 g
Equipment Filter Wipe Blanks							
	HDPE	4 oz.	TBD	Metals	4±2°C	6 months	1 wipe
	HDPE	4 oz.	TBD	Mercury	4±2°C	28 Days	1 wipe
	AG	4 oz.	TBD	Dioxins/furans	4±2°C	1 year/1 year [e]	1 wipe
	AG	4 oz.	TBD	PCBs	4±2°C	7 days/40 days [e]	1 wipe
	AG	4 oz.	TBD	Semivolatile organic compound	4±2°C	7 days/40 days [e]	1 wipe

Notes

AG = amber glass
HDPE = high density polyethylene
NA = not applicable
TBD = to be determined
WMG = wide mouth glass
[a] The size and number of containers may be modified by the analytical laboratory.
[b] Sample sizes may be modified one laboratory selection is made.
[c] Samples will be shipped to the laboratory on ice at 4±2°C. Once received at the laboratory, samples will be stored at -20°C.
[d] Extracts will be stored at -10°C.
[e] Holding time for samples prior to extraction/ holding time for extracts.
[f] Published holding time does not exist. Holding time shown is based on best professional judgment.
[g] See Soil Study SAP for additional details on soil sampling and analyses.

FIGURES

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ANCHOR QEA integral consulting inc.

US EPA's Preliminary Site Boundary
Original (1966) Perimeter of the Northern Impoundments
Area of Groundwater Investigation South of I-10

0 800
Scale in Feet

* Designation of the sand separation area is intended to be a general reference to areas in which such activities are believed to have taken place based on visual observations of aerial photography from 1998 through 2002.

FEATURE SOURCES:
Aerial Imagery: 0.5-meter. Photo Date: 01/14/2009
Texas Strategic Mapping Program (StratMap), TNRIS

Figure A-1
Overview of Current Site
SJRWP Groundwater Study SAP
SJRWP Superfund Site/MIMC and IPC

DRAFT
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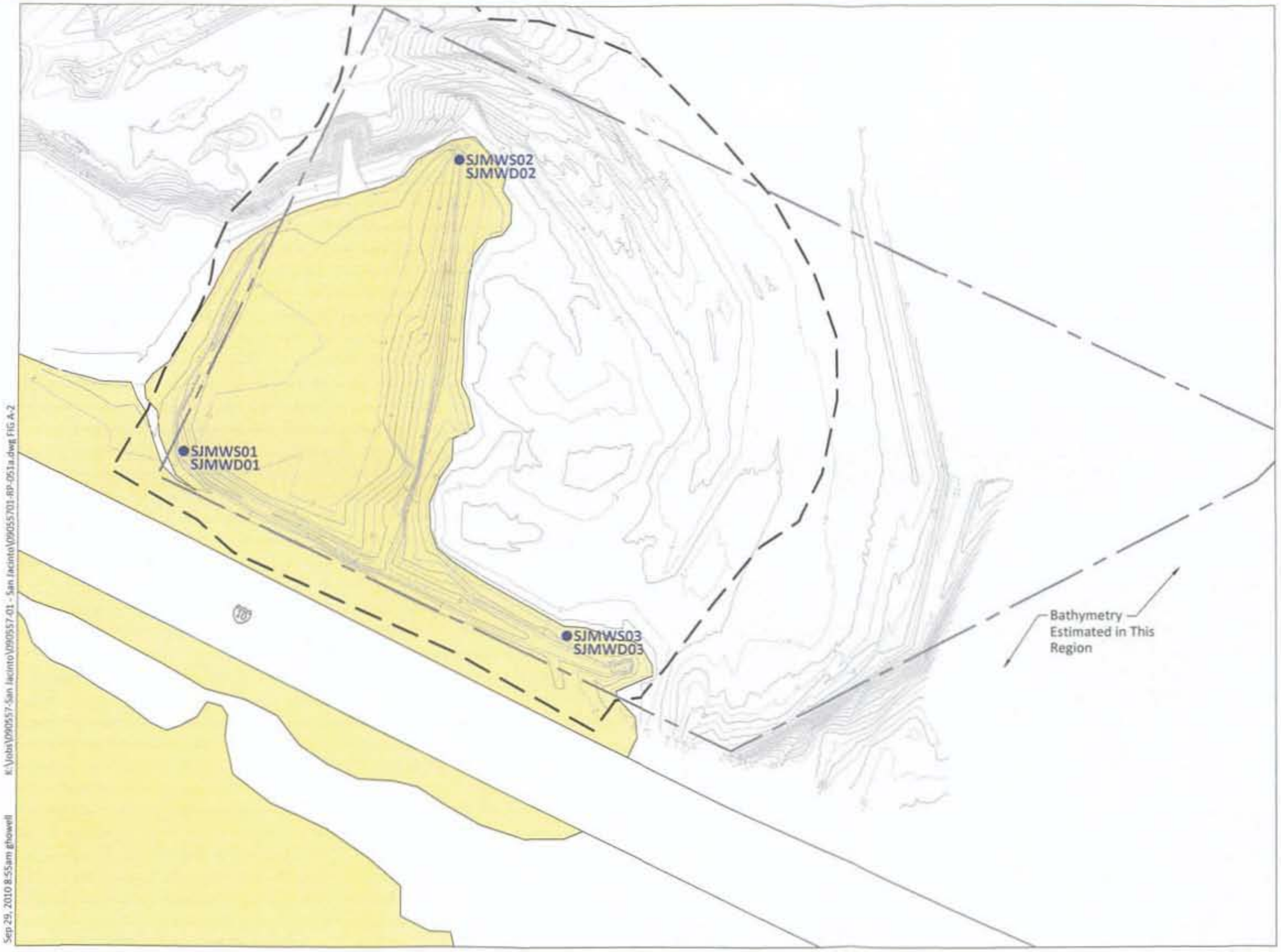

Proposed Well Pairs	Easting	Northing
SJWMS01/D01	3216663.9445	13857373.7160
SJWMS02/D02	3217053.9683	13857791.3563
SJWMS03/D03	3217206.9071	13857112.8596

LEGEND:

Approximate 1966 Berm Alignment Perimeter

Virgil C. McGinnes Trustee Property Line

Approximate Limit of Vegetated Area (Shoreline)

SJMWS01 SJMWD01 Monitoring Well Pair (Proposed)

0 150

Scale in Feet

SOURCE: Drawing prepared from electronic file provided by US Army Corps of Engineers.
HORIZONTAL DATUM: Texas South Central NAD 83, US Survey Feet.
VERTICAL DATUM: NAVD 88.
NOTE:
Proposed boring locations are depicted in gray scale.

Sep 29, 2010 8:55am ghowell K:\Jobs\090557-San Jacinto\090557-01 - San Jacinto\09055701-RP-051a.dwg FIG A-2

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Figure A-2
Proposed Monitoring Well Pairs
SJRWP Groundwater Study SAP
SJRWP Superfund Site/MIMC and IPC

ATTACHMENT A-1
STANDARD OPERATING PROCEDURES

Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)[1]

This standard is issued under the fixed designation D 2488; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope *

1.1 This practice covers procedures for the description of soils for engineering purposes.

1.2 This practice also describes a procedure for identifying soils, at the option of the user, based on the classification system described in Test Method D 2487. The identification is based on visual examination and manual tests. It must be clearly stated in reporting an identification that it is based on visual-manual procedures.

1.2.1 When precise classification of soils for engineering purposes is required, the procedures prescribed in Test Method D 2487 shall be used.

1.2.2 In this practice, the identification portion assigning a group symbol and name is limited to soil particles smaller than 3 in. (75 mm).

1.2.3 The identification portion of this practice is limited to naturally occurring soils (disturbed and undisturbed).

NOTE 1—This practice may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, etc. (see Appendix X2).

1.3 The descriptive information in this practice may be used with other soil classification systems or for materials other than naturally occurring soils.

1.4 The values stated in inch-pound units are to be regarded as the standard.

1.5 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements see Section 8.

1.6 *This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 1452 Practice for Soil Investigation and Sampling by Auger Borings[2]

D 1586 Test Method for Penetration Test and Split-Barrel Sampling of Soils[2]

D 1587 Practice for Thin-Walled Tube Sampling of Soils[2]

D 2113 Practice for Diamond Core Drilling for Site Investigation[2]

D 2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System)[2]

D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and rock as Used in Engineering Design and Construction[3]

D 4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)[2]

3. Terminology

3.1 *Definitions*—Except as listed below, all definitions are in accordance with Terminology D 653.

NOTE 2—For particles retained on a 3-in. (75-mm) US standard sieve, the following definitions are suggested:
Cobbles—particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) sieve, and
Boulders—particles of rock that will not pass a 12-in. (300-mm) square opening.

3.1.1 *clay*—soil passing a No. 200 (75-μm) sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry. For classification, a clay is a fine-grained soil, or the

[1] This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

Current edition approved Feb. 10, 2000. Published May 2000. Originally published as D 2488 – 66 T. Last previous edition D 2488 – 93$^{\epsilon 1}$.

[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 04.09.

***A Summary of Changes section appears at the end of this standard.**

fine-grained portion of a soil, with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid limit falls on or above the "A" line (see Fig. 3 of Test Method D 2487).

3.1.2 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

coarse—passes a 3-in. (75-mm) sieve and is retained on a ¾-in. (19-mm) sieve.

fine—passes a ¾-in. (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

3.1.3 *organic clay*—a clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay, except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.4 *organic silt*—a silt with sufficient organic content to influence the soil properties. For classification, an organic silt is a soil that would be classified as a silt except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.5 *peat*—a soil composed primarily of vegetable tissue in various stages of decomposition usually with an organic odor, a dark brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.

3.1.6 *sand*—particles of rock that will pass a No. 4 (4.75-mm) sieve and be retained on a No. 200 (75-μm) sieve with the following subdivisions:

coarse—passes a No. 4 (4.75-mm) sieve and is retained on a No. 10 (2.00-mm) sieve.

medium—passes a No. 10 (2.00-mm) sieve and is retained on a No. 40 (425-μm) sieve.

fine—passes a No. 40 (425-μm) sieve and is retained on a No. 200 (75-μm) sieve.

3.1.7 *silt*—soil passing a No. 200 (75-μm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dry. For classification, a silt is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index less than 4, or the plot of plasticity index versus liquid limit falls below the "A" line (see Fig. 3 of Test Method D 2487).

4. Summary of Practice

4.1 Using visual examination and simple manual tests, this practice gives standardized criteria and procedures for describing and identifying soils.

4.2 The soil can be given an identification by assigning a group symbol(s) and name. The flow charts, Fig. 1a and Fig. 1b for fine-grained soils, and Fig. 2, for coarse-grained soils, can be used to assign the appropriate group symbol(s) and name. If the soil has properties which do not distinctly place it into a specific group, borderline symbols may be used, see Appendix X3.

NOTE 3—It is suggested that a distinction be made between *dual symbols* and *borderline symbols*.

Dual Symbol—A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC, CL-ML used to indicate that the soil has been identified as having the properties of a classification in accordance with Test Method D 2487 where two symbols are required. Two symbols are required when the soil has between 5 and 12 % fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

Borderline Symbol—A borderline symbol is two symbols separated by a slash, for example, CL/CH, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that do not distinctly place the soil into a specific group (see Appendix X3).

5. Significance and Use

5.1 The descriptive information required in this practice can be used to describe a soil to aid in the evaluation of its significant properties for engineering use.

5.2 The descriptive information required in this practice should be used to supplement the classification of a soil as determined by Test Method D 2487.

5.3 This practice may be used in identifying soils using the classification group symbols and names as prescribed in Test Method D 2487. Since the names and symbols used in this practice to identify the soils are the same as those used in Test Method D 2487, it shall be clearly stated in reports and all other appropriate documents, that the classification symbol and name are based on visual-manual procedures.

5.4 This practice is to be used not only for identification of soils in the field, but also in the office, laboratory, or wherever soil samples are inspected and described.

5.5 This practice has particular value in grouping similar soil samples so that only a minimum number of laboratory tests need be run for positive soil classification.

NOTE 4—The ability to describe and identify soils correctly is learned more readily under the guidance of experienced personnel, but it may also be acquired systematically by comparing numerical laboratory test results for typical soils of each type with their visual and manual characteristics.

5.6 When describing and identifying soil samples from a given boring, test pit, or group of borings or pits, it is not necessary to follow all of the procedures in this practice for every sample. Soils which appear to be similar can be grouped together; one sample completely described and identified with the others referred to as similar based on performing only a few of the descriptive and identification procedures described in this practice.

5.7 This practice may be used in combination with Practice D 4083 when working with frozen soils.

NOTE 5—Notwithstanding the statements on precision and bias contained in this standard: The precision of this test method is dependent on the competence of the personnel performing it and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective testing. Users of this test method are cautioned that compliance with Practice D 3740 does not in itself assure reliable testing. Reliable testing depends on several factors; Practice D 3740 provides a means for evaluating some of those factors.

6. Apparatus

6.1 *Required Apparatus*:

6.1.1 *Pocket Knife or Small Spatula.*

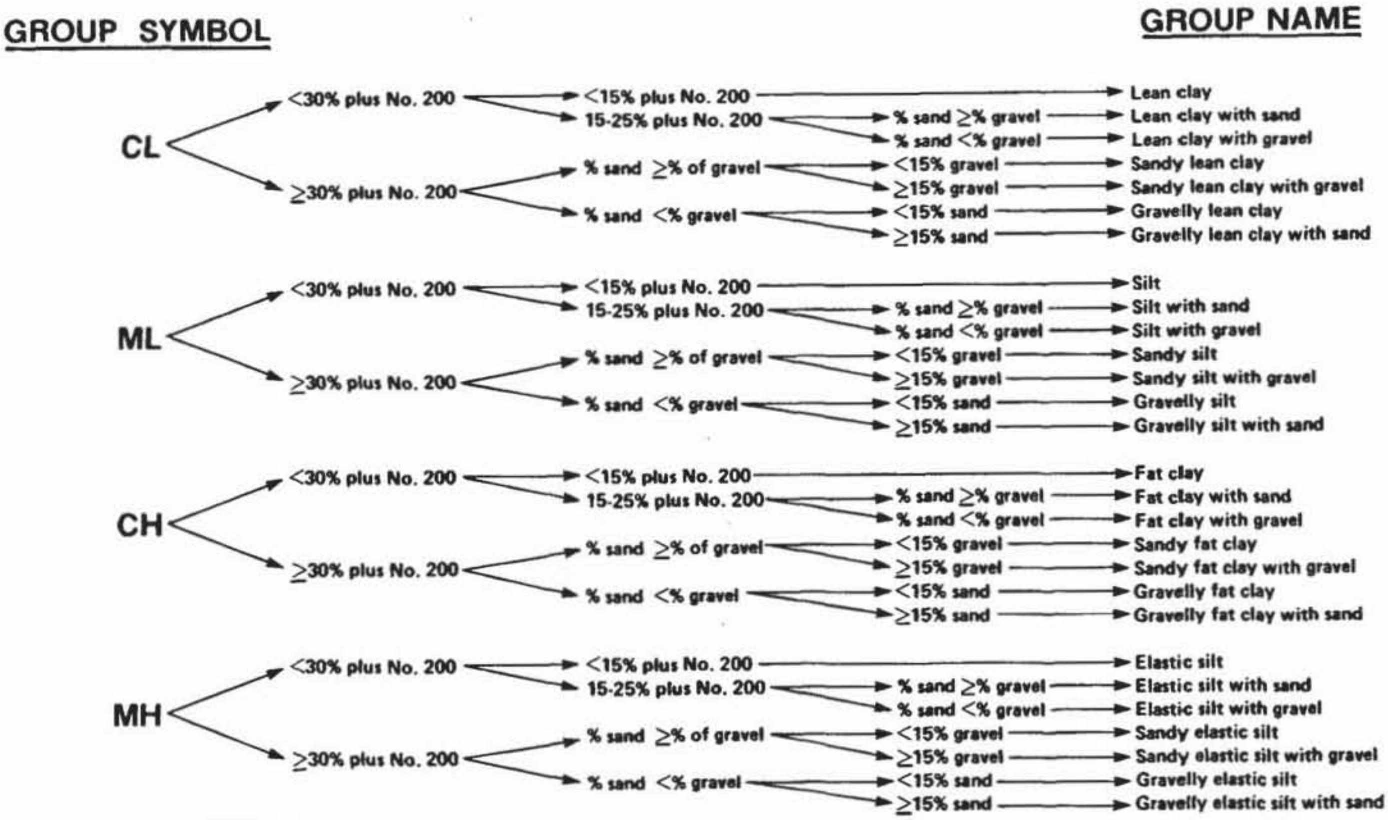
6.2 *Useful Auxiliary Apparatus*:

6.2.1 *Small Test Tube and Stopper* (or jar with a lid).

6.2.2 *Small Hand Lens.*

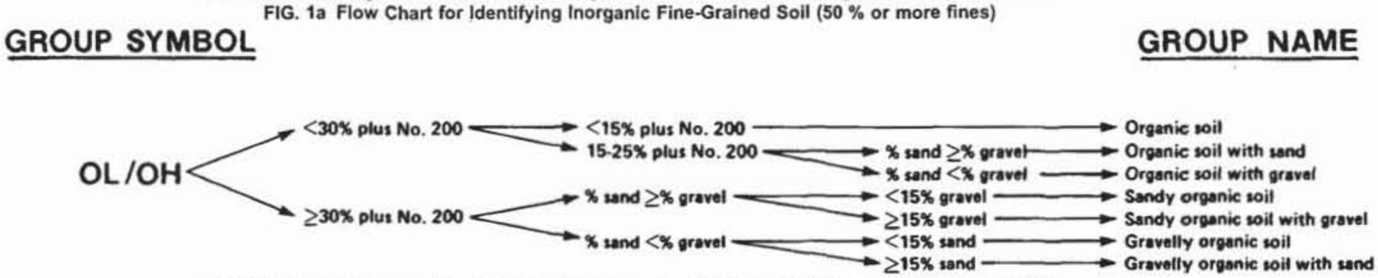
7. Reagents

7.1 *Purity of Water*—Unless otherwise indicated, references



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1 b Flow Chart for Identifying Organic Fine-Grained Soil (50 % or more fines)

to water shall be understood to mean water from a city water supply or natural source, including non-potable water.

7.2 *Hydrochloric Acid*—A small bottle of dilute hydrochloric acid, HCl, one part HCl (10 *N*) to three parts water (This reagent is optional for use with this practice). See Section 8.

8. Safety Precautions

8.1 When preparing the dilute HCl solution of one part concentrated hydrochloric acid (10 *N*) to three parts of distilled water, slowly add acid into water following necessary safety precautions. Handle with caution and store safely. If solution comes into contact with the skin, rinse thoroughly with water.

8.2 **Caution**—Do not add water to acid.

9. Sampling

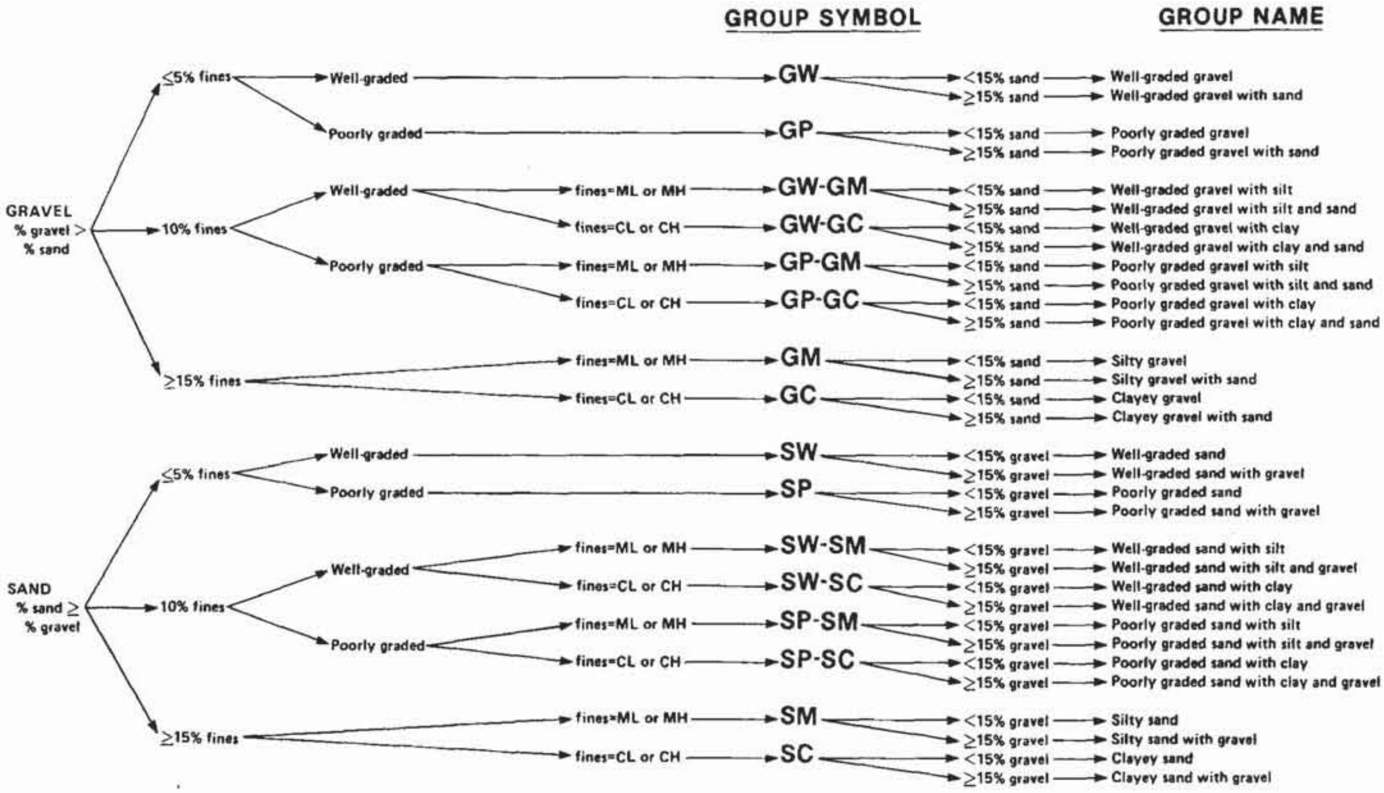
9.1 The sample shall be considered to be representative of the stratum from which it was obtained by an appropriate, accepted, or standard procedure.

NOTE 6—Preferably, the sampling procedure should be identified as having been conducted in accordance with Practices D 1452, D 1587, or D 2113, or Test Method D 1586.

9.2 The sample shall be carefully identified as to origin.

NOTE 7—Remarks as to the origin may take the form of a boring number and sample number in conjunction with a job number, a geologic stratum, a pedologic horizon or a location description with respect to a permanent monument, a grid system or a station number and offset with respect to a stated centerline and a depth or elevation.

9.3 For accurate description and identification, the minimum amount of the specimen to be examined shall be in accordance with the following schedule:



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

Maximum Particle Size, Sieve Opening	Minimum Specimen Size, Dry Weight
4.75 mm (No. 4)	100 g (0.25 lb)
9.5 mm (3/8 in.)	200 g (0.5 lb)
19.0 mm (3/4 in.)	1.0 kg (2.2 lb)
38.1 mm (1 1/2 in.)	8.0 kg (18 lb)
75.0 mm (3 in.)	60.0 kg (132 lb)

NOTE 8—If random isolated particles are encountered that are significantly larger than the particles in the soil matrix, the soil matrix can be accurately described and identified in accordance with the preceeding schedule.

9.4 If the field sample or specimen being examined is smaller than the minimum recommended amount, the report shall include an appropriate remark.

10. Descriptive Information for Soils

10.1 *Angularity*—Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded in accordance with the criteria in Table 1 and Fig. 3. A range of angularity may be stated, such as: subrounded to rounded.

10.2 *Shape*—Describe the shape of the gravel, cobbles, and boulders as flat, elongated, or flat and elongated if they meet the criteria in Table 2 and Fig. 4. Otherwise, do not mention the shape. Indicate the fraction of the particles that have the shape, such as: one-third of the gravel particles are flat.

10.3 *Color*—Describe the color. Color is an important property in identifying organic soils, and within a given locality it may also be useful in identifying materials of similar geologic origin. If the sample contains layers or patches of varying colors, this shall be noted and all representative colors shall be described. The color shall be described for moist samples. If the color represents a dry condition, this shall be stated in the report.

10.4 *Odor*—Describe the odor if organic or unusual. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation. This is especially apparent in fresh samples, but if the samples are dried, the odor may often be revived by heating a moistened sample. If the odor is unusual (petroleum product, chemical, and the like), it shall be described.

10.5 *Moisture Condition*—Describe the moisture condition as dry, moist, or wet, in accordance with the criteria in Table 3.

10.6 *HCl Reaction*—Describe the reaction with HCl as none, weak, or strong, in accordance with the critera in Table 4. Since calcium carbonate is a common cementing agent, a report of its presence on the basis of the reaction with dilute hydrochloric acid is important.

10.7 *Consistency*—For intact fine-grained soil, describe the

TABLE 1 Criteria for Describing Angularity of Coarse-Grained Particles (see Fig. 3)

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

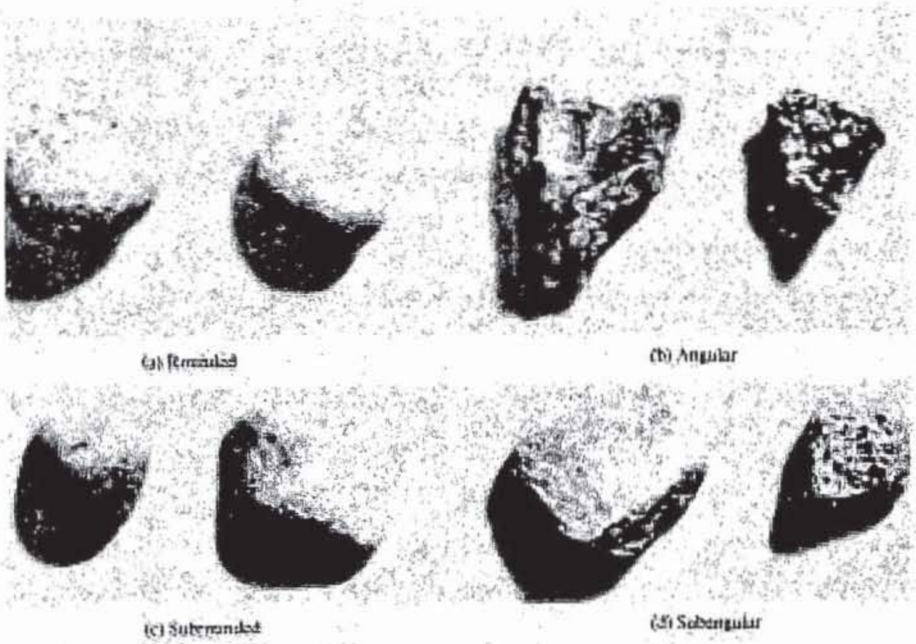


FIG. 3 Typical Angularity of Bulky Grains

TABLE 2 Criteria for Describing Particle Shape (see Fig. 4)

The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively.

Flat	Particles with width/thickness > 3
Elongated	Particles with length/width > 3
Flat and elongated	Particles meet criteria for both flat and elongated

consistency as very soft, soft, firm, hard, or very hard, in accordance with the criteria in Table 5. This observation is inappropriate for soils with significant amounts of gravel.

10.8 *Cementation*—Describe the cementation of intact coarse-grained soils as weak, moderate, or strong, in accordance with the criteria in Table 6.

10.9 *Structure*—Describe the structure of intact soils in accordance with the criteria in Table 7.

10.10 *Range of Particle Sizes*—For gravel and sand components, describe the range of particle sizes within each component as defined in 3.1.2 and 3.1.6. For example, about 20 % fine to coarse gravel, about 40 % fine to coarse sand.

10.11 *Maximum Particle Size*—Describe the maximum particle size found in the sample in accordance with the following information:

10.11.1 *Sand Size*—If the maximum particle size is a sand size, describe as fine, medium, or coarse as defined in 3.1.6. For example: maximum particle size, medium sand.

10.11.2 *Gravel Size*—If the maximum particle size is a gravel size, describe the maximum particle size as the smallest sieve opening that the particle will pass. For example, maximum particle size, 1½ in. (will pass a 1½-in. square opening but not a ¾-in. square opening).

10.11.3 *Cobble or Boulder Size*—If the maximum particle size is a cobble or boulder size, describe the maximum dimension of the largest particle. For example: maximum dimension, 18 in. (450 mm).

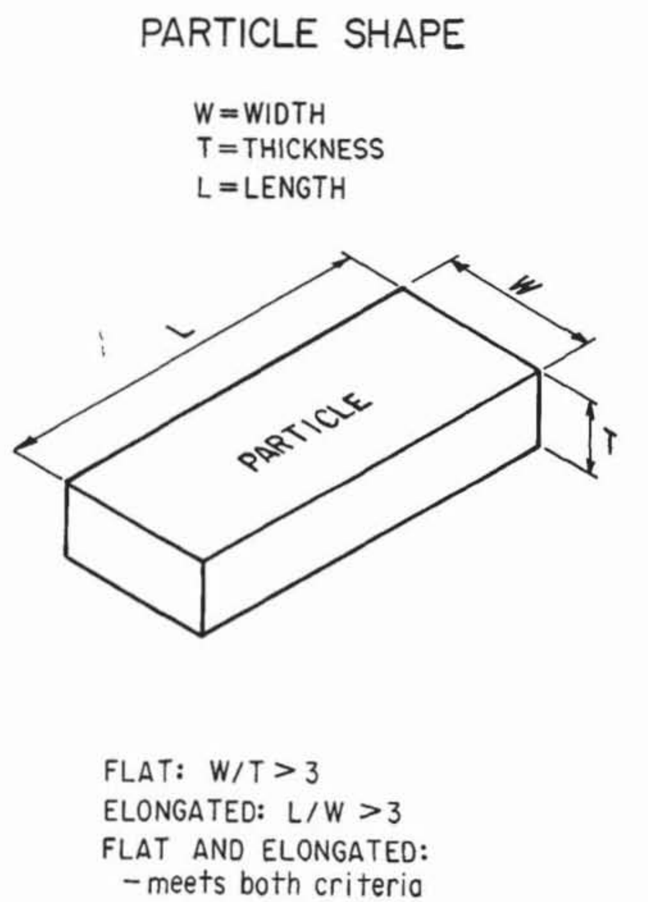


FIG. 4 Criteria for Particle Shape

10.12 *Hardness*—Describe the hardness of coarse sand and larger particles as hard, or state what happens when the

TABLE 3 Criteria for Describing Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

TABLE 4 Criteria for Describing the Reaction With HCl

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

TABLE 5 Criteria for Describing Consistency

Description	Criteria
Very soft	Thumb will penetrate soil more than 1 in. (25 mm)
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about ¼in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very hard	Thumbnail will not indent soil

TABLE 6 Criteria for Describing Cementation

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

TABLE 7 Criteria for Describing Structure

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

particles are hit by a hammer, for example, gravel-size particles fracture with considerable hammer blow, some gravel-size particles crumble with hammer blow. "Hard" means particles do not crack, fracture, or crumble under a hammer blow.

10.13 Additional comments shall be noted, such as the presence of roots or root holes, difficulty in drilling or augering hole, caving of trench or hole, or the presence of mica.

10.14 A local or commercial name or a geologic interpretation of the soil, or both, may be added if identified as such.

10.15 A classification or identification of the soil in accordance with other classification systems may be added if identified as such.

11. Identification of Peat

11.1 A sample composed primarily of vegetable tissue in various stages of decomposition that has a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor, shall be designated as a highly organic soil and shall be identified as peat, PT, and not subjected to the identification procedures described hereafter.

12. Preparation for Identification

12.1 The soil identification portion of this practice is based on the portion of the soil sample that will pass a 3-in. (75-mm) sieve. The larger than 3-in. (75-mm) particles must be removed, manually, for a loose sample, or mentally, for an intact sample before classifying the soil.

12.2 Estimate and note the percentage of cobbles and the percentage of boulders. Performed visually, these estimates will be on the basis of volume percentage.

NOTE 9—Since the percentages of the particle-size distribution in Test Method D 2487 are by dry weight, and the estimates of percentages for gravel, sand, and fines in this practice are by dry weight, it is recommended that the report state that the percentages of cobbles and boulders are by volume.

12.3 Of the fraction of the soil smaller than 3 in. (75 mm), estimate and note the percentage, by dry weight, of the gravel, sand, and fines (see Appendix X4 for suggested procedures).

NOTE 10—Since the particle-size components appear visually on the basis of volume, considerable experience is required to estimate the percentages on the basis of dry weight. Frequent comparisons with laboratory particle-size analyses should be made.

12.3.1 The percentages shall be estimated to the closest 5 %. The percentages of gravel, sand, and fines must add up to 100 %.

12.3.2 If one of the components is present but not in sufficient quantity to be considered 5 % of the smaller than 3-in. (75-mm) portion, indicate its presence by the term *trace*, for example, trace of fines. A trace is not to be considered in the total of 100 % for the components.

13. Preliminary Identification

13.1 The soil is *fine grained* if it contains 50 % or more fines. Follow the procedures for identifying fine-grained soils of Section 14.

13.2 The soil is *coarse grained* if it contains less than 50 % fines. Follow the procedures for identifying coarse-grained soils of Section 15.

14. Procedure for Identifying Fine-Grained Soils

14.1 Select a representative sample of the material for examination. Remove particles larger than the No. 40 sieve (medium sand and larger) until a specimen equivalent to about a handful of material is available. Use this specimen for performing the dry strength, dilatancy, and toughness tests.

14.2 *Dry Strength*:

14.2.1 From the specimen, select enough material to mold into a ball about 1 in. (25 mm) in diameter. Mold the material until it has the consistency of putty, adding water if necessary.

14.2.2 From the molded material, make at least three test specimens. A test specimen shall be a ball of material about ½ in. (12 mm) in diameter. Allow the test specimens to dry in air, or sun, or by artificial means, as long as the temperature does not exceed 60°C.

14.2.3 If the test specimen contains natural dry lumps, those that are about ½ in. (12 mm) in diameter may be used in place of the molded balls.

NOTE 11—The process of molding and drying usually produces higher strengths than are found in natural dry lumps of soil.

14.2.4 Test the strength of the dry balls or lumps by crushing between the fingers. Note the strength as none, low, medium, high, or very high in accorance with the criteria in Table 8. If natural dry lumps are used, do not use the results of any of the lumps that are found to contain particles of coarse sand.

14.2.5 The presence of high-strength water-soluble cementing materials, such as calcium carbonate, may cause exceptionally high dry strengths. The presence of calcium carbonate can usually be detected from the intensity of the reaction with dilute hydrochloric acid (see 10.6).

14.3 *Dilatancy*:

14.3.1 From the specimen, select enough material to mold into a ball about ½ in. (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.

14.3.2 Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 9. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

14.4 *Toughness*:

14.4.1 Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about ⅛ in. (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about ⅛ in. The thread will crumble at a diameter of ⅛ in. when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading.

14.4.2 Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 10.

14.5 *Plasticity*—On the basis of observations made during the toughness test, describe the plasticity of the material in accordance with the criteria given in Table 11.

14.6 Decide whether the soil is an *inorganic* or an *organic* fine-grained soil (see 14.8). If inorganic, follow the steps given in 14.7.

14.7 *Identification of Inorganic Fine-Grained Soils*:

14.7.1 Identify the soil as a *lean clay*, CL, if the soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity (see Table 12).

14.7.2 Identify the soil as a *fat clay*, CH, if the soil has high to very high dry strength, no dilatancy, and high toughness and plasticity (see Table 12).

14.7.3 Identify the soil as a *silt*, ML, if the soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic (see Table 12).

14.7.4 Identify the soil as an *elastic silt*, MH, if the soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity (see Table 12).

NOTE 12—These properties are similar to those for a lean clay. However, the silt will dry quickly on the hand and have a smooth, silky feel when dry. Some soils that would classify as MH in accordance with the criteria in Test Method D 2487 are visually difficult to distinguish from lean clays, CL. It may be necessary to perform laboratory testing for proper identification.

14.8 *Identification of Organic Fine-Grained Soils*:

14.8.1 Identify the soil as an *organic soil*, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

NOTE 13—In some cases, through practice and experience, it may be possible to further identify the organic soils as organic silts or organic clays, OL or OH. Correlations between the dilatancy, dry strength, toughness tests, and laboratory tests can be made to identify organic soils in certain deposits of similar materials of known geologic origin.

TABLE 8 Criteria for Describing Dry Strength

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface
Very high	The dry specimen cannot be broken between the thumb and a hard surface

TABLE 9 Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

TABLE 10 Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness

TABLE 11 Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A ⅛-in. (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

TABLE 12 Identification of Inorganic Fine-Grained Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

14.9 If the soil is estimated to have 15 to 25 % sand or gravel, or both, the words "with sand" or "with gravel" (whichever is more predominant) shall be added to the group name. For example: "lean clay with sand, CL" or "silt with gravel, ML" (see Fig. 1a and Fig. 1b). If the percentage of sand is equal to the percentage of gravel, use "with sand."

14.10 If the soil is estimated to have 30 % or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if there appears to be more sand than gravel. Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy lean clay, CL", "gravelly fat clay, CH", or "sandy silt, ML" (see Fig. 1a and Fig. 1b). If the percentage of sand is equal to the percent of gravel, use "sandy."

15. Procedure for Identifying Coarse-Grained Soils

(Contains less than 50 % fines)

15.1 The soil is a *gravel* if the percentage of gravel is estimated to be more than the percentage of sand.

15.2 The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

15.3 The soil is a *clean gravel* or *clean sand* if the percentage of fines is estimated to be 5 % or less.

15.3.1 Identify the soil as a *well-graded gravel*, GW, or as a *well-graded sand*, SW, if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes.

15.3.2 Identify the soil as a *poorly graded gravel*, GP, or as a *poorly graded sand*, SP, if it consists predominantly of one size (uniformly graded), or it has a wide range of sizes with some intermediate sizes obviously missing (gap or skip graded).

15.4 The soil is either a *gravel with fines* or a *sand with fines* if the percentage of fines is estimated to be 15 % or more.

15.4.1 Identify the soil as a *clayey gravel*, GC, or a *clayey sand*, SC, if the fines are clayey as determined by the procedures in Section 14.

15.4.2 Identify the soil as a *silty gravel*, GM, or a *silty sand*, SM, if the fines are silty as determined by the procedures in Section 14.

15.5 If the soil is estimated to contain 10 % fines, give the soil a dual identification using two group symbols.

15.5.1 The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a gravel or sand with fines (GC, GM, SC, SM).

15.5.2 The group name shall correspond to the first group symbol plus the words "with clay" or "with silt" to indicate the plasticity characteristics of the fines. For example: "well-graded gravel with clay, GW-GC" or "poorly graded sand with silt, SP-SM" (see Fig. 2).

15.6 If the specimen is predominantly sand or gravel but contains an estimated 15 % or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "poorly graded gravel with sand, GP" or "clayey sand with gravel, SC" (see Fig. 2).

15.7 If the field sample contains any cobbles or boulders, or both, the words "with cobbles" or "with cobbles and boulders" shall be added to the group name. For example: "silty gravel with cobbles, GM."

16. Report

16.1 The report shall include the information as to origin, and the items indicated in Table 13.

NOTE 14—*Example: Clayey Gravel with Sand and Cobbles, GC*—About 50 % fine to coarse, subrounded to subangular gravel; about 30 % fine to coarse, subrounded sand; about 20 % fines with medium plasticity, high dry strength, no dilatancy, medium toughness; weak reaction with HCl; original field sample had about 5 % (by volume) subrounded cobbles, maximum dimension, 150 mm.

In-Place Conditions—Firm, homogeneous, dry, brown

Geologic Interpretation—Alluvial fan

TABLE 13 Checklist for Description of Soils

1. Group name
2. Group symbol
3. Percent of cobbles or boulders, or both (by volume)
4. Percent of gravel, sand, or fines, or all three (by dry weight)
5. Particle-size range:
   Gravel—fine, coarse
   Sand—fine, medium, coarse
6. Particle angularity: angular, subangular, subrounded, rounded
7. Particle shape: (if appropriate) flat, elongated, flat and elongated
8. Maximum particle size or dimension
9. Hardness of coarse sand and larger particles
10. Plasticity of fines: nonplastic, low, medium, high
11. Dry strength: none, low, medium, high, very high
12. Dilatancy: none, slow, rapid
13. Toughness: low, medium, high
14. Color (in moist condition)
15. Odor (mention only if organic or unusual)
16. Moisture: dry, moist, wet
17. Reaction with HCl: none, weak, strong

For intact samples:

18. Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
19. Structure: stratified, laminated, fissured, slickensided, lensed, homogeneous
20. Cementation: weak, moderate, strong
21. Local name
22. Geologic interpretation
23. Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

NOTE 15—Other examples of soil descriptions and identification are given in Appendix X1 and Appendix X2.

NOTE 16—If desired, the percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages, as follows:

Trace—Particles are present but estimated to be less than 5 %

Few—5 to 10 %

Little—15 to 25 %

Some—30 to 45 %

Mostly—50 to 100 %

16.2 If, in the soil description, the soil is identified using a classification group symbol and name as described in Test Method D 2487, it must be distinctly and clearly stated in log forms, summary tables, reports, and the like, that the symbol and name are based on visual-manual procedures.

17. Precision and Bias

17.1 This practice provides qualitative information only, therefore, a precision and bias statement is not applicable.

18. Keywords

18.1 classification; clay; gravel; organic soils; sand; silt; soil classification; soil description; visual classification

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLES OF VISUAL SOIL DESCRIPTIONS

X1.1 The following examples show how the information required in 16.1 can be reported. The information that is included in descriptions should be based on individual circumstances and need.

X1.1.1 *Well-Graded Gravel with Sand (GW)*—About 75 % fine to coarse, hard, subangular gravel; about 25 % fine to coarse, hard, subangular sand; trace of fines; maximum size, 75 mm, brown, dry; no reaction with HCl.

X1.1.2 *Silty Sand with Gravel (SM)*—About 60 % predominantly fine sand; about 25 % silty fines with low plasticity, low dry strength, rapid dilatancy, and low toughness; about 15 % fine, hard, subrounded gravel, a few gravel-size particles fractured with hammer blow; maximum size, 25 mm; no reaction with HCl (Note—Field sample size smaller than recommended).

In-Place Conditions—Firm, stratified and contains lenses of silt 1 to 2 in. (25 to 50 mm) thick, moist, brown to gray; in-place density 106 lb/ft^3; in-place moisture 9 %.

X1.1.3 *Organic Soil (OL/OH)*—About 100 % fines with low plasticity, slow dilatancy, low dry strength, and low toughness; wet, dark brown, organic odor; weak reaction with HCl.

X1.1.4 *Silty Sand with Organic Fines (SM)*—About 75 % fine to coarse, hard, subangular reddish sand; about 25 % organic and silty dark brown nonplastic fines with no dry strength and slow dilatancy; wet; maximum size, coarse sand; weak reaction with HCl.

X1.1.5 *Poorly Graded Gravel with Silt, Sand, Cobbles and Boulders (GP-GM)*—About 75 % fine to coarse, hard, subrounded to subangular gravel; about 15 % fine, hard, subrounded to subangular sand; about 10 % silty nonplastic fines; moist, brown; no reaction with HCl; original field sample had about 5 % (by volume) hard, subrounded cobbles and a trace of hard, subrounded boulders, with a maximum dimension of 18 in. (450 mm).

X2. USING THE IDENTIFICATION PROCEDURE AS A DESCRIPTIVE SYSTEM FOR SHALE, CLAYSTONE, SHELLS, SLAG, CRUSHED ROCK, AND THE LIKE

X2.1 The identification procedure may be used as a descriptive system applied to materials that exist in-situ as shale, claystone, sandstone, siltstone, mudstone, etc., but convert to soils after field or laboratory processing (crushing, slaking, and the like).

X2.2 Materials such as shells, crushed rock, slag, and the like, should be identified as such. However, the procedures used in this practice for describing the particle size and plasticity characteristics may be used in the description of the material. If desired, an identification using a group name and symbol according to this practice may be assigned to aid in describing the material.

X2.3 The group symbol(s) and group names should be placed in quotation marks or noted with some type of distinguishing symbol. See examples.

X2.4 Examples of how group names and symbols can be incororated into a descriptive system for materials that are not naturally occurring soils are as follows:

X2.4.1 *Shale Chunks*—Retrieved as 2 to 4-in. (50 to 100-mm) pieces of shale from power auger hole, dry, brown, no reaction with HCl. After slaking in water for 24 h, material identified as "Sandy Lean Clay (CL)"; about 60 % fines with medium plasticity, high dry strength, no dilatancy, and medium toughness; about 35 % fine to medium, hard sand; about 5 % gravel-size pieces of shale.

X2.4.2 *Crushed Sandstone*—Product of commercial crushing operation; "Poorly Graded Sand with Silt (SP-SM)"; about 90 % fine to medium sand; about 10 % nonplastic fines; dry, reddish-brown, strong reaction with HCl.

X2.4.3 *Broken Shells*—About 60 % gravel-size broken shells; about 30 % sand and sand-size shell pieces; about 10 % fines; "Poorly Graded Gravel with Sand (GP)."

X2.4.4 *Crushed Rock*—Processed from gravel and cobbles in Pit No. 7; "Poorly Graded Gravel (GP)"; about 90 % fine, hard, angular gravel-size particles; about 10 % coarse, hard, angular sand-size particles; dry, tan; no reaction with HCl.

X3. SUGGESTED PROCEDURE FOR USING A BORDERLINE SYMBOL FOR SOILS WITH TWO POSSIBLE IDENTIFICATIONS.

X3.1 Since this practice is based on estimates of particle size distribution and plasticity characteristics, it may be difficult to clearly identify the soil as belonging to one category. To indicate that the soil may fall into one of two possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example: SC/CL or CL/CH.

X3.1.1 A borderline symbol may be used when the percentage of fines is estimated to be between 45 and 55 %. One symbol should be for a coarse-grained soil with fines and the other for a fine-grained soil. For example: GM/ML or CL/SC.

X3.1.2 A borderline symbol may be used when the percentage of sand and the percentage of gravel are estimated to be about the same. For example: GP/SP, SC/GC, GM/SM. It is practically impossible to have a soil that would have a borderline symbol of GW/SW.

X3.1.3 A borderline symbol may be used when the soil could be either well graded or poorly graded. For example: GW/GP, SW/SP.

X3.1.4 A borderline symbol may be used when the soil could either be a silt or a clay. For example: CL/ML, CH/MH, SC/SM.

X3.1.5 A borderline symbol may be used when a fine-grained soil has properties that indicate that it is at the boundary between a soil of low compressibility and a soil of high compressibility. For example: CL/CH, MH/ML.

X3.2 The order of the borderline symbols should reflect similarity to surrounding or adjacent soils. For example: soils in a borrow area have been identified as CH. One sample is considered to have a borderline symbol of CL and CH. To show similarity, the borderline symbol should be CH/CL.

X3.3 The group name for a soil with a borderline symbol should be the group name for the first symbol, except for:

CL/CH lean to fat clay
ML/CL clayey silt
CL/ML silty clay

X3.4 The use of a borderline symbol should not be used indiscriminately. Every effort shall be made to first place the soil into a single group.

X4. SUGGESTED PROCEDURES FOR ESTIMATING THE PERCENTAGES OF GRAVEL, SAND, AND FINES IN A SOIL SAMPLE

X4.1 *Jar Method*—The relative percentage of coarse- and fine-grained material may be estimated by thoroughly shaking a mixture of soil and water in a test tube or jar, and then allowing the mixture to settle. The coarse particles will fall to the bottom and successively finer particles will be deposited with increasing time; the sand sizes will fall out of suspension in 20 to 30 s. The relative proportions can be estimated from the relative volume of each size separate. This method should be correlated to particle-size laboratory determinations.

X4.2 *Visual Method*—Mentally visualize the gravel size particles placed in a sack (or other container) or sacks. Then, do the same with the sand size particles and the fines. Then, mentally compare the number of sacks to estimate the percentage of plus No. 4 sieve size and minus No. 4 sieve size present. The percentages of sand and fines in the minus sieve size No. 4 material can then be estimated from the wash test (X4.3).

X4.3 *Wash Test (for relative percentages of sand and fines)*—Select and moisten enough minus No. 4 sieve size material to form a 1-in (25-mm) cube of soil. Cut the cube in half, set one-half to the side, and place the other half in a small dish. Wash and decant the fines out of the material in the dish until the wash water is clear and then compare the two samples and estimate the percentage of sand and fines. Remember that the percentage is based on weight, not volume. However, the volume comparison will provide a reasonable indication of grain size percentages.

X4.3.1 While washing, it may be necessary to break down lumps of fines with the finger to get the correct percentages.

X5. ABBREVIATED SOIL CLASSIFICATION SYMBOLS

X5.1 In some cases, because of lack of space, an abbreviated system may be useful to indicate the soil classification symbol and name. Examples of such cases would be graphical logs, databases, tables, etc.

X5.2 This abbreviated system is not a substitute for the full name and descriptive information but can be used in supplementary presentations when the complete description is referenced.

X5.3 The abbreviated system should consist of the soil classification symbol based on this standard with appropriate lower case letter prefixes and suffixes as:

Prefix:	Suffix:
s = sandy	s = with sand
g = gravelly	g = with gravel
	c = with cobbles
	b = with boulders

X5.4 The soil classification symbol is to be enclosed in parenthesis. Some examples would be:

Group Symbol and Full Name	Abbreviated
CL, Sandy lean clay	s(CL)
SP-SM, Poorly graded sand with silt and gravel	(SP-SM)g
GP, poorly graded gravel with sand, cobbles, and boulders	(GP)scb
ML, gravelly silt with sand and cobbles	g(ML)sc

SUMMARY OF CHANGES

In accordance with Committee D18 policy, this section identifies the location of changes to this standard since the last edition ($1993^{\epsilon 1}$) that may impact the use of this standard.

(1) Added Practice D 3740 to Section 2.

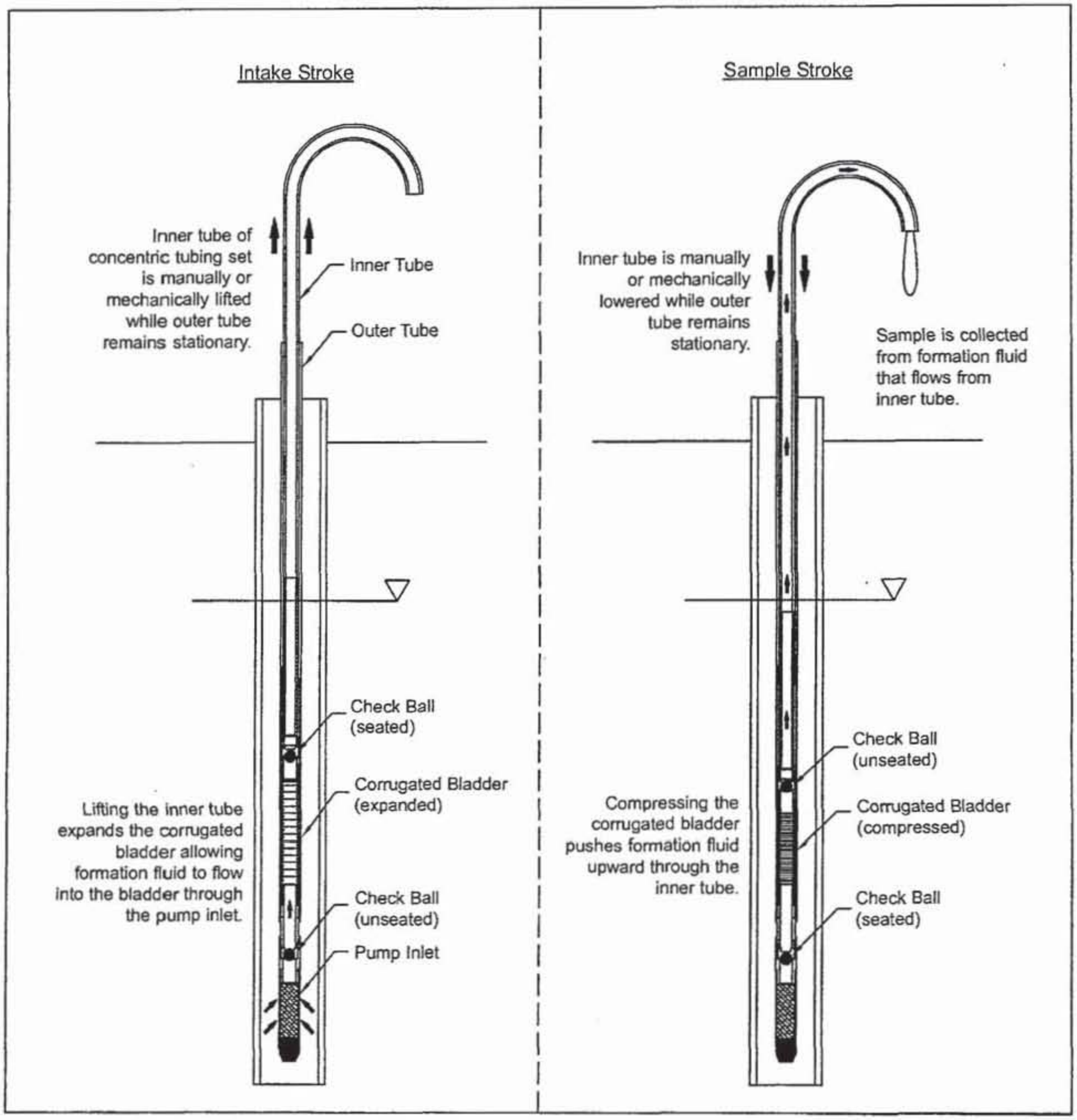
(2) Added Note 5 under 5.7 and renumbered subsequent notes.

Geoprobe® Model MB470 Mechanical Bladder Pump

Standard Operating Procedure

Technical Bulletin No. MK3013

PREPARED: November, 2003
REVISED: July, 2006



INTAKE AND SAMPLE STROKES OF THE MB470 MECHANICAL BLADDER PUMP

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The Mechanical Bladder Pump is manufactured under
U.S. Patent No. 6,877,965 issued April 12, 2005.

1.0 OBJECTIVE

The objective of this document is to provide guidance on how to collect a representative sample of the subsurface formation fluid utilizing the Geoprobe® Model MB470 Mechanical Bladder Pump.

2.0 BACKGROUND

2.1 Definitions

Geoprobe®*: A brand name of high quality, hydraulically-powered machines that utilize both static force and percussion to advance sampling and logging tools into the subsurface. The Geoprobe® brand name refers to both machines and tools manufactured by Geoprobe Systems®, Salina, Kansas. Geoprobe® tools are used to perform soil core and soil gas sampling, groundwater sampling and testing, soil conductivity and contaminant logging, grouting, and materials injection.
**Geoprobe® and Geoprobe Systems® are registered trademarks of Kejr, Inc., Salina, Kansas.*

MB470 Mechanical Bladder Pump (MBP):** A device for obtaining high-quality, low-turbidity samples from groundwater monitoring wells and direct push installed groundwater samplers as small as .5 inches (13 mm) inside diameter (ID). The MBP may be used to meet requirements of the low-flow sampling protocol (Puls and Barcelona 1996, ASTM 2003). Through participation in a U.S. EPA Environmental Technology Verification study, it was confirmed that the MB470 can provide representative samples (EPA 2003).
***The Mechanical Bladder Pump is manufactured under U.S. Patent No. 6,877,965 issued April 12, 2005.*

Within the MB470 pump body, a corrugated Teflon® fluorinated ethylene propylene (FEP) bladder is mechanically compressed and expanded to push groundwater to the surface through a concentric tubing set. Check valves above and below the bladder control flow direction. The outer tube of the concentric tubing set holds the pump body in place while the inner tube is used to actuate the bladder and transmit water to the surface. The pump body and internal components are made of stainless steel with an outside diameter (OD) of .47 inches (12 mm) and an overall length of 26.75 inches (679 mm) with an inlet screen assembly installed.

2.2 MBP System Components

The three basic components of the Model MB470 Mechanical Bladder Pump system are the pump, concentric tubing set, and actuator.

Pump

All pump components (Fig. 2.1) are made of stainless steel material with the exception of the three fluorosilicone O-rings and the Teflon® bladder.

Beginning at the downhole end of the pump, either a Bullet Nose Intake (P/N 20675) or Inlet Screen Assembly (P/N 20725) may be used as determined by project requirements. The screen assembly includes a 60 mesh wire screen with an actual screen length of 6 inches (152 mm). The bullet nose intake is open at the leading end and provides no filtering effect.

Above the intake/inlet, the pump body contains the corrugated bladder and check balls that physically move groundwater to the surface for purging and sampling. As the top of the bladder is extended, the expanding action of the bladder draws groundwater into the bladder through the intake/inlet. Compressing the bladder then pushes the groundwater up through the connected inner tube of the concentric tubing set. Check balls at the Upper and Lower Bladder Adapters (P/N 20679 and 20677) control groundwater flow through the bladder.

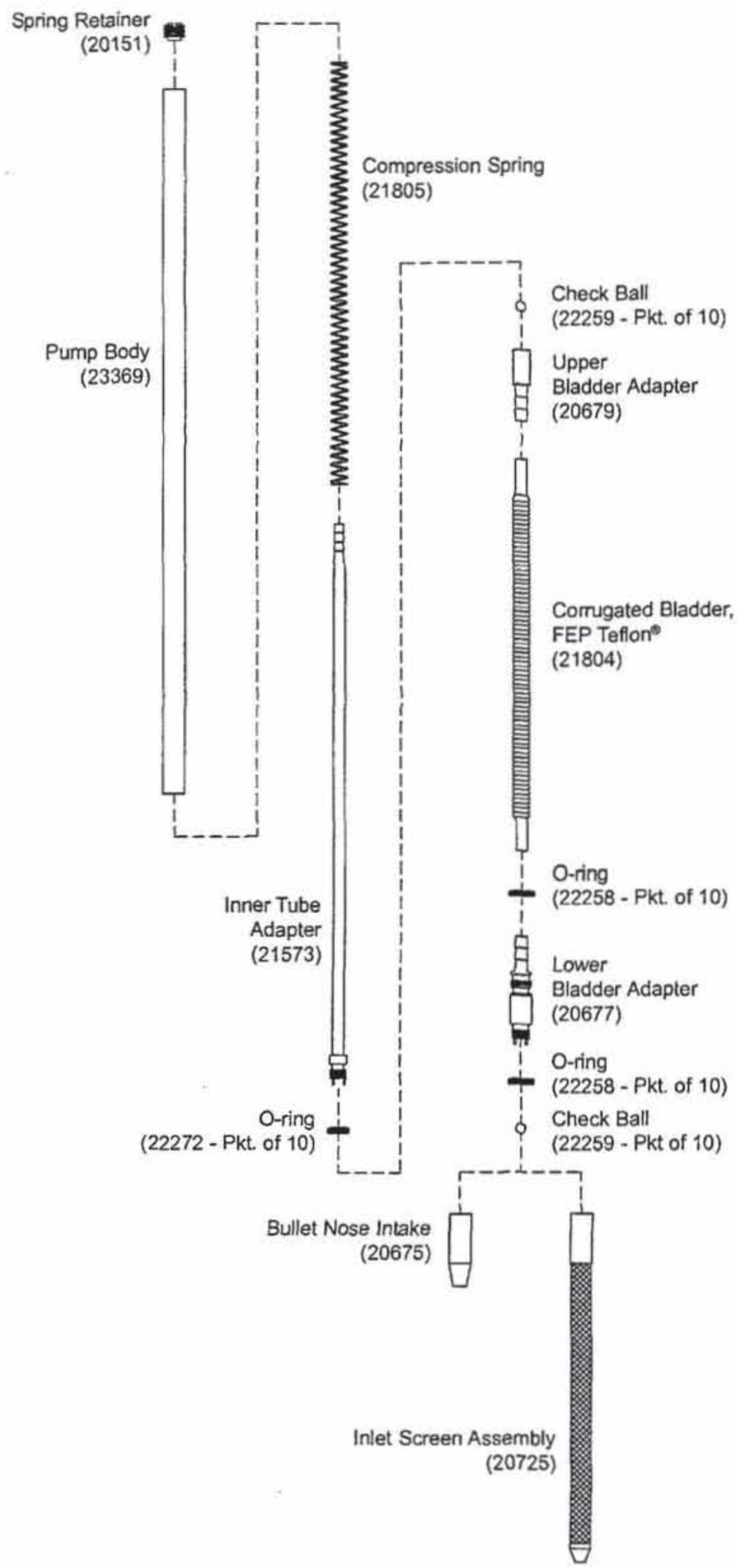


Figure 2.1: Components of MB470 Pump.

The lower end of the corrugated bladder is secured to the pump body by the Lower Bladder Adapter (P/N 20677). The top of the bladder is attached to the inner tube of the concentric tubing set by the Upper Bladder Adapter (P/N 20679) and Inner Tube Adapter (P/N 21573). During operation of the pump, the inner tube is raised and lowered to expand and contract the bladder to move formation fluid to ground surface.

Concentric Tubing Set

A concentric tubing set for the MB470 Mechanical Bladder Pump commonly consists of .19-inch (5 mm) ID / .25-inch (6 mm) OD Teflon® fluorinated ethylene propylene (FEP) tubing surrounded by .31-inch (8 mm) ID / .44-inch (11 mm) OD high-density polyethylene (HDPE) tubing. Where allowed by project requirements, other materials (e.g. low-density polyethylene (LDPE) tubing) may be utilized in place of the Teflon® inner tubing.

Available lengths for the concentric tubing set are 50 and 100 feet (15.2 and 30.5 m). Custom lengths may be assembled from 500-foot rolls of appropriate tubing sizes and materials, some of which are listed on Page 6.

Refer to the magnified view in Figure 2.2. The inner tube of the concentric tubing set is attached to the Inner Tube Adapter (P/N 21573) during assembly of the MB470 pump. The outer tube is then threaded inside the top end of the pump body. Once lowered down the sampler or monitoring well, the outer tube is held stationary either manually or by attachment to a mechanical actuator. The inner tube is raised and lowered by hand or through use of the mechanical actuator to expand and compress the pump bladder. Formation fluid is thus drawn into the pump bladder and then pushed to ground surface.

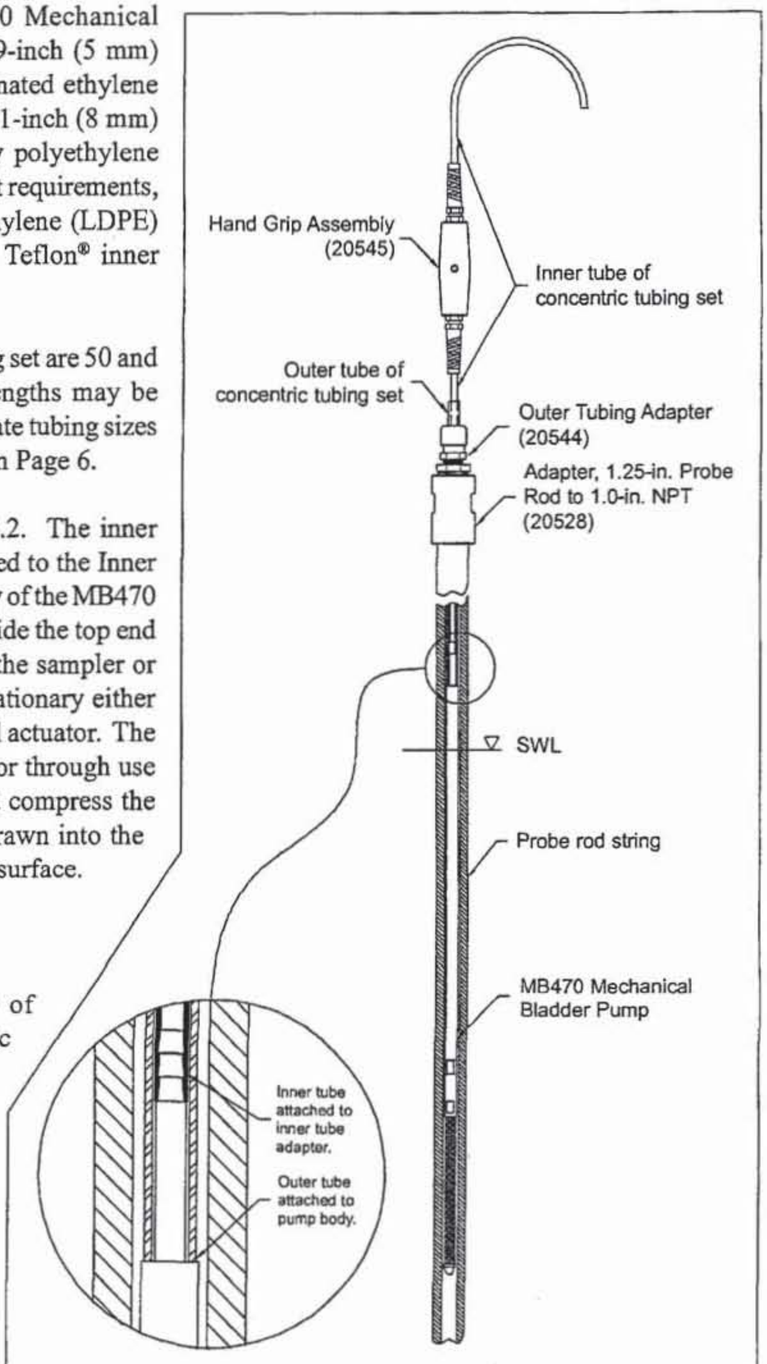


Figure 2.2: MB470 Mechanical Bladder Pump and manual actuator as used in a direct push installed groundwater sampler.

Actuator

Actuators provide the physical means of holding the outer tube of the concentric tubing set stationary while cycling the inner tube up-and-down. Actuator kits are available for manually or mechanically powering the MB470 pump.

For the manual actuator shown in Figure 2.2, the outer tube of the concentric tubing set is attached to the probe rods using two adapters. The inner tubing is raised and lowered by hand to obtain the groundwater sample. Refer to Section 4.4 for more actuator options.

3.0 REQUIRED EQUIPMENT

The following equipment is required to collect representative groundwater samples using the Model MB470 Mechanical Bladder Pump. Refer to Figure 3.1 for identification of the specified parts.

Pump Components	Quantity	Part Number
Mechanical Bladder Pump	-1-	MB470
Service Parts Kit, for MB470 Pump	-1-	MB7500
Includes: O-ring Pick	-1-	AT102
Corrugated Bladder, Teflon® FEP	-3-	21804
Compression Spring, Stainless Steel (SS)	-1-	21805
O-rings for Lower Bladder Adapter (#5-585 Fluorosilicone), Pkg. of 10	-1-	22258
O-rings for Inner Tube Adapter (#010 Fluorosilicone), Pkg. of 10	-1-	22272
Check Balls (7/32-in. diameter), SS, Pkg. of 10	-1-	22259
MBP Assembly Tool	-1-	20456
MBP Cleaning Brush Kit	-1-	MB7300
MBP Assembly Tool	-1-	20456

Tubing Options	Quantity	Part Number
Concentric Tubing Set, HDPE (outer)/FEP (inner), .44-in. OD x 50-ft. length	Variable	MB5050
Concentric Tubing Set, HDPE/FEP, .44-in. OD - 100-ft. length	Variable	MB5100
Concentric Tubing Set, HDPE/LDPE, .44-in. OD - 50-ft. length	Variable	MB5051
Concentric Tubing Set, HDPE/LDPE, .44-in. OD - 100-ft. length	Variable	MB5101
Concentric Tubing Set, HDPE/PP, .44-in. OD - 50-ft. length	Variable	MB5052
Concentric Tubing Set, HDPE/PP, .44-in. OD - 100-ft. length	Variable	MB5102
LDPE Tubing, .19-in. ID x .25-in. OD - 100-ft. length	Variable	TB171L
LDPE Tubing, .19-in. ID x .25-in. OD - 500-ft. length	Variable	TB17L
Teflon® FEP Tubing, .19-in. ID x .25-in. OD - 50-ft. length	Variable	TB17T
Teflon® FEP Tubing, .19-in. ID x .25-in. OD - 100-ft. length	Variable	TB171T
Teflon® FEP Tubing, .19-in. ID x .25-in. OD - 500-ft. length	Variable	TB175T
PP Tubing, .17-in. ID x .25-in. OD - 50-ft. length	Variable	TB17P
PP Tubing, .17-in. ID x .25-in. OD - 100-ft. length	Variable	TB171P
HDPE Tubing, .31-in. ID x .44-in. OD - 50-ft. length	Variable	TB31H
HDPE Tubing, .31-in. ID x .44-in. OD - 100-ft. length	Variable	TB311H
HDPE Tubing, .31-in. ID x .44-in. OD - 500-ft. length	Variable	TB315H

Actuator Options	Quantity	Part Number
Manual Actuator Kit	-1-	MB7000
Includes: Hand Grip Assembly	-1-	20545
Outer Tubing Grip	-1-	22758
Outer Tubing Adapter	-1-	20544
Mechanical Actuator Assembly	-1-	MB6000
Electric Actuator Assembly, 12VDC	-1-	MB6120
Electric Actuator Kit, 12VDC	-1	MB6120K
Well Mount Kit (for use with MB6000)	-1-	MB7200

Adapters for Use with Actuators	Quantity	Part Number
MBP PVC Riser Adapter Kit	-1-	MB7100
Includes: PVC Extension, 1.0-in. NPT Pin x 1.0-in. NPT Pin - 12-in. Length	-1-	17560
PVC Coupling, 1.0-in. NPT Box x 1.0-in. NPT Box	-1-	21145
Adapter, 2.0-in. PVC to 1.0-in. NPT Pin	-1-	22759
O-rings for 2.0-in. PVC to 1.0-in. NPT Pin Adapter, pkg. of 25	-1-	22313
Adapter, 1.0-in. PVC to 1.0-in. NPT Pin	-1-	17558
O-rings for 1.0-in. PVC to 1.0-in. NPT Pin Adapter, pkg. of 25	-1-	13942
Adapter, 0.75-in. PVC to 17558 Adapter (0.75-in. PVC requires 2 adapters)	-1-	19424
O-rings for 0.75-in. PVC to 17558 Adapter, pkg. of 25	-1-	13196
Adapter, 0.5-in. PVC to 17558 Adapter (0.5-in. PVC requires 2 adapters)	-1-	17559
O-rings for 0.5-in. PVC to 17558 Adapter, pkg. of 25	-1-	GW1555R
Adapter, Geoprobe® 1.0-in. Probe Rod Pin to 1.0-in. NPT Pin	-1-	20527
Adapter, Geoprobe® 1.25-in. Probe Rod Pin to 1.0-in. NPT Pin	-1-	20528
Adapter, Geoprobe® 1.5-in. Probe Rod Pin to 1.0-in. NPT Pin	-1-	20529

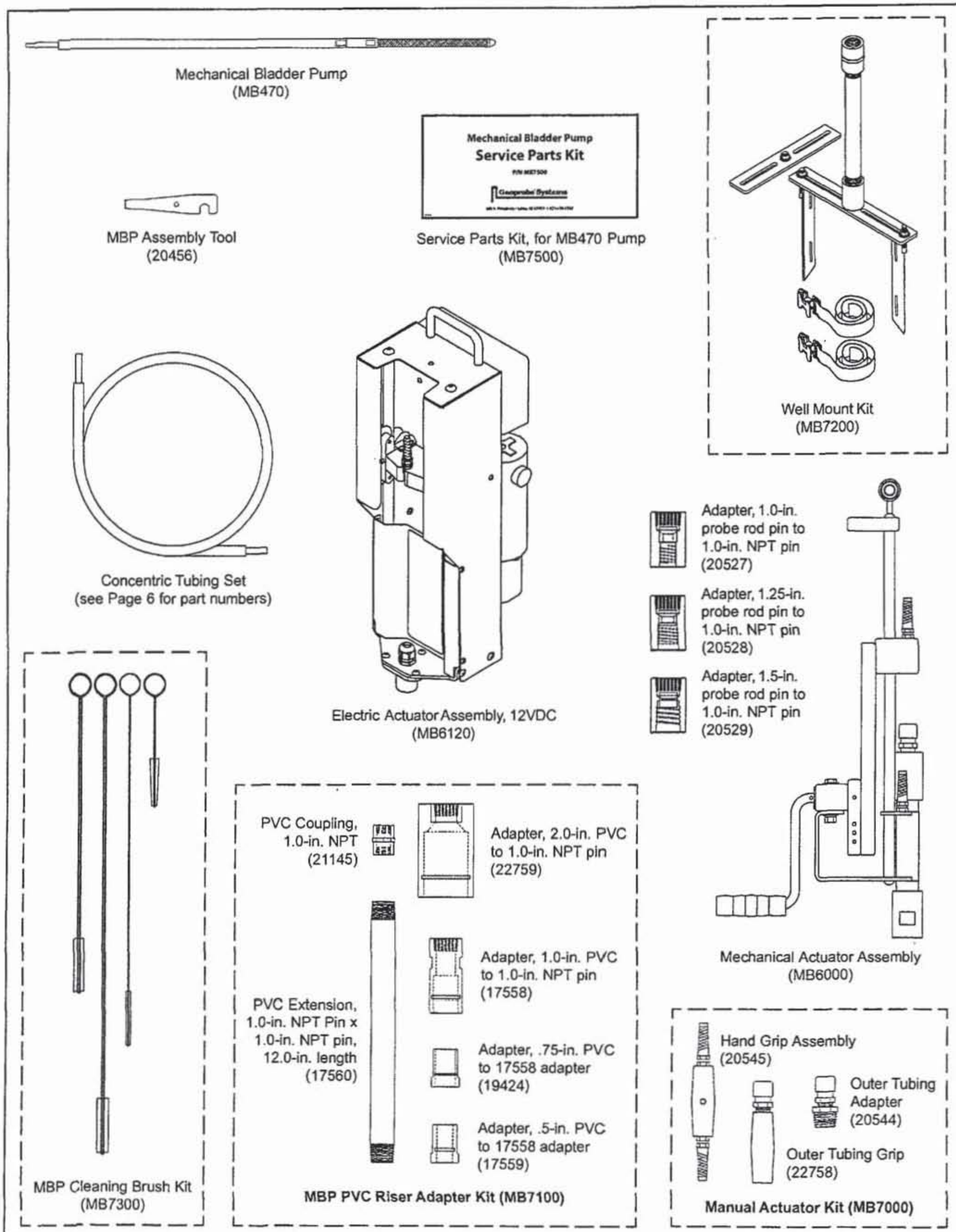


Figure 3.1: MB470 Mechanical Bladder Pump parts and accessories.

4.0 OPERATION

Use and operation of the MB470 Mechanical Bladder Pump may be divided into five main steps:

- *Assembling the Pump*
- *Selecting and installing the concentric tubing set*
- *Selecting and installing the actuator*
- *Purging and sampling*
- *Decontaminating the Pump*

4.1 Assembling the Pump

This section identifies the procedures for assembling the components of the MB470 Mechanical Bladder Pump and performing a leak check on the corrugated bladder. Refer to Figure 4.1 for parts identification.

1. Ensure that all metal parts are clean and free of burrs that may damage the pump threads or the corrugated bladder during assembly.

2. Install two fluorosilicone O-rings (22258) on the Lower Bladder Adapter (20677). Note that these are the larger of the two sizes of O-rings used with the MB470 pump.

3. Lubricate the O-ring of the lower bladder adapter and inside the Bullet Nose Intake (20675) with DI water. Place a Check Ball (22259) in the bullet nose intake and thread the intake onto the lower bladder adapter.

NOTE: The bullet nose intake is used here to make it easier to leak check the pump later in this procedure. After the leak check has been performed, the bullet nose intake may be replaced with a Screen Inlet Assembly (20725) if desired.

4. Install a fluorosilicone O-ring (22272) on the lower end of the Inner Tube Adapter (21573). Note that this is the smaller of the two sizes of O-rings used with the MB470 pump.

5. Lubricate the O-ring of the inner tube adapter and inside the Upper Bladder Adapter (20679) with DI water. Thread the upper bladder adapter onto the inner tube adapter.

NOTE: A check ball must be installed in the upper bladder adapter after performing the leak check in Step 7.

6. Install the Teflon® FEP Corrugated Bladder (21804):

   - The bladder should be installed with the corrugations pointing "up" (toward the upper bladder adapter/ inner tube adapter) as indicated in Figure 4.2.
   - Firmly push and rotate the lower cuff of the bladder over the barbed end of the lower bladder adapter.
   - Firmly push and rotate the upper cuff of the bladder over the barbed end of the upper bladder adapter.
   - Both ends of the bladder should be fully seated on the adapter barbs.

CAUTION: Although firmness is required during installation of the bladder, avoid crushing, kinking, or twisting the bladder corrugations to prevent damage.

7. Perform a leak check on the corrugated bladder before fully assembling the pump components to ensure that the bladder is free of defects. (Leak check procedure is given on opposite page.)

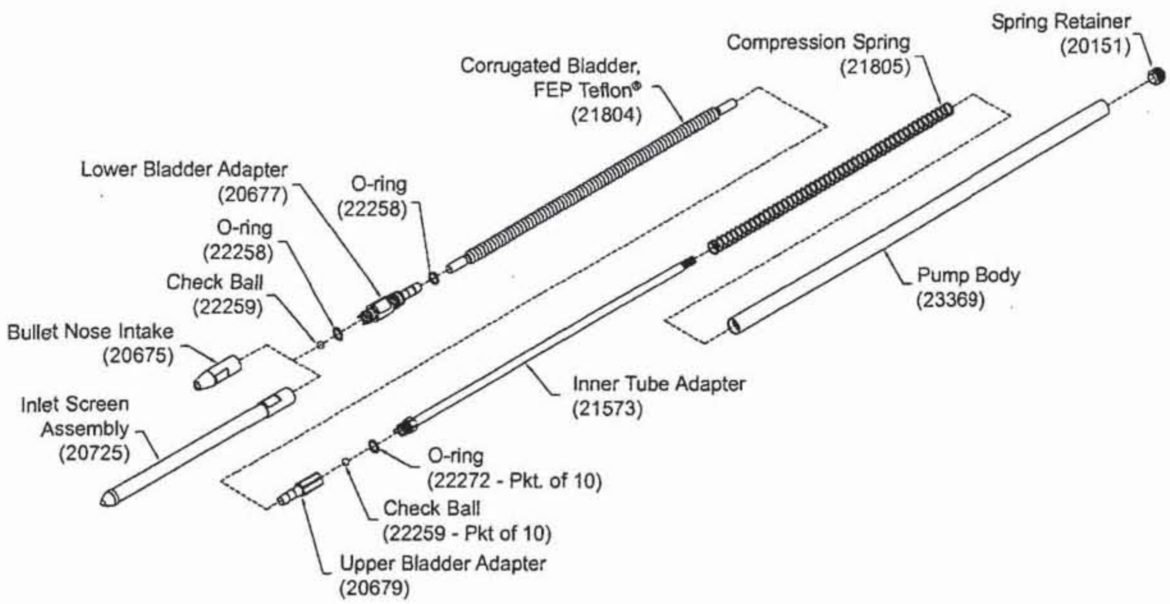


Figure 4.1: Isometric exploded view of the MB470 Mechanical Bladder Pump.

Leak check the corrugated bladder as follows:

- Completely submerge the bladder and lower end of the inner tube adapter in a clean beaker or small bucket of distilled or DI water.
- Firmly blow into the open end of the inner tube adapter. Leaks in the bladder or assembled parts will be indicated by bubbles.
- If leaks are found, replace the faulty O-ring(s) or bladder. Retest to ensure that all leakage has stopped.
- Once the pump has passed the leak test, unthread the upper bladder adapter from the inner tube adapter. Place a Check Ball (22259) in the upper bladder adapter and reinstall it in the inner tube adapter.
- Replace the bullet nose intake with an Inlet Screen Assembly (20725) if desired. Remember to include the check ball when installing the inlet screen.

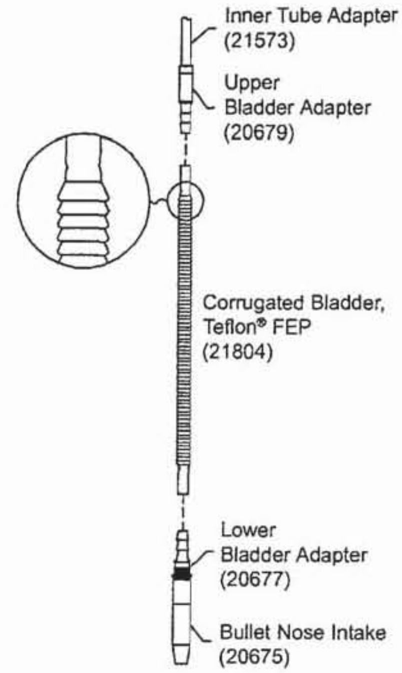


Figure 4.2: Bladder corrugations should point "up".

8. The Pump Body (23369) is internally threaded at each end. Threads run all the way to the end of the pump body at the upper end, but stop .25 inches (6 mm) from the end at the lower end of the pump body to permit an O-ring seal.

   Thread the Spring Retainer (20151) into the top of the pump body. Install the retainer with the slotted end out to allow use of a medium slotted screw driver or the MBP Assembly Tool (20456) to thread or unthread the retainer.

9. Place the Compression Spring (21805) over the top of the inner tube adapter. Slide the spring completely onto the adapter until it contacts the hex fitting.

10. Slide the lower end of the pump body over the top of the inner tube adapter and pump spring. The inner tube adapter will slip through the spring retainer and extend approximately 3 inches (75 mm) from the top of the pump body.

11. The lower bladder adapter is now threaded into the pump body to complete the assembly process.

    - Lubricate the O-ring on the lower bladder adapter and inside the lower end of the pump body with DI water.
    - Grasp the pump body with one hand and the lower bladder adapter with the other hand.
    - Gently compress the spring and bladder into the pump body.
    - Thread the lower bladder adapter into the pump body. Use care to avoid cutting or pinching the O-ring while threading the parts together. The O-ring will no longer be visible when the adapter is fully seated.

Assembly of the MB470 Mechanical Bladder Pump is now complete.

4.2 Selecting and Installing the Concentric Tubing Set

Selecting the Concentric Tubing Material and Length

The outer tube of the concentric tubing set commonly consists of .44-inch OD x .31-inch ID (11.2 mm x 7.9 mm) HDPE material. Inner tube material options are Teflon® FEP, LDPE, or PP. Teflon® FEP and LDPE tubing have dimensions of .25-inch OD x .19-inch ID (6.4 mm x 4.8 mm) while the PP tubing measures .25-inch OD x .17-inch ID (6.4 mm x 4.3 mm).

LDPE inner tubes are the least expensive option. The elasticity of this material may be excessive for deeper wells and in warm ambient conditions (summertime). Teflon® FEP inner tubes are less elastic and provide higher sample quality compared to LDPE due to the chemical properties of the two materials. Teflon® FEP also has a lower coefficient of friction for smoother actuation of the bladder and less resistance to operation, especially at greater depths. The main drawback of Teflon® FEP is its higher cost. PP inner tubes provide a compromise between LDPE and Teflon® FEP in that they are less elastic and provide higher sample quality than LDPE at a lower cost than Teflon® FEP.

While Teflon® FEP exhibits relatively good chemical inertness, it will absorb and desorb some volatile organic contaminants (Parker & Ranney 1998). Because of this, ambient groundwater should be purged through the pump and tubing system for a period of time to achieve equilibrium between the bladder and tubing and sample fluid. The period of time may vary for different volatile organic compounds (VOCs), but if low flow sampling (Puls and Barcelona 1996, ASTM 2003) is conducted, chemical equilibrium may be achieved by the time the monitored water quality parameters (DO, ORP, turbidity, etc.) have stabilized.

Preassembled concentric tubing sets are available from Geoprobe Systems® in lengths of 50 and 100 feet (15.2 and 30.5 m). The user may choose to assemble sets of custom lengths from separate rolls of inner and outer tubing in preparation for the sampling event or while on-site. Be careful to keep the tubing clean while inserting the inner tube into the outer tube.

When long tubing sets are required, it may be wise to use clean PVC riser pipe to protect the tubing during assembly. Simply thread PVC riser sections together, placing them on the shop floor or along the ground surface. Cap one end of the casing to keep dirt and debris out during assembly. Determine the length of the outer tube required and make the PVC casing about the same length. Slide the outer tube into the PVC casing and cut to the desired length. Slide the inner tube into the outer tube. Cut the inner tube three or more feet longer than the outer tube to complete the concentric tubing set.

Keep all tubing stored in clean airtight bags or containers so that dirt, dust, and cross contamination are not a concern or problem. No matter how clean the pump is, sample quality will suffer if the tubing is dirty. Be sure the tubing is of clean, quality material and is not marked with inks that may contribute to cross contamination.

Installing the Concentric Tubing Set on the MB470 Pump

The concentric tubing set is attached to the mechanical bladder pump by pushing the inner tube onto the hose barb on the end of the inner tube adapter and then threading the outer tube into the pump body.

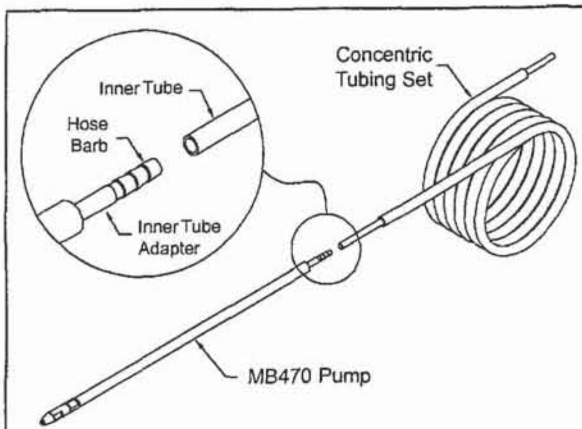


Figure 4.3: Fully seat the inner tube onto the hose barbs of the inner tube adapter.

1. Push the inner tube of the concentric tubing set onto the hose barb on the end of the inner tube adapter (Fig. 4.3). Fully seat the tube on the adapter such that the tube engages all three barbs. Take care not to kink or otherwise damage the tubing.

2. Before installing the outer tube, unthread the lower bladder adapter from the pump body and lay the partially disassembled pump on a clean, level surface. This step is recommended so that the bladder is not twisted or damaged as the outer tubing is installed.

3. Push and thread the outer tube into the top end of the pump body (Fig. 4.4). The outer tube should be threaded about 0.75 inches (19 mm) into the pump body until it butts against the spring retainer. Remember to take care not to kink or otherwise damage the tubing during installation.

4. Rotate the lower bladder adapter counterclockwise one or two revolutions to minimize torque on the bladder when threading the adapter into the pump body. Now reinstall the lower bladder adapter and inner tube adapter into the lower end of the pump body.

   The pump and tubing set are now assembled and ready for installation into the monitoring well or sampler.

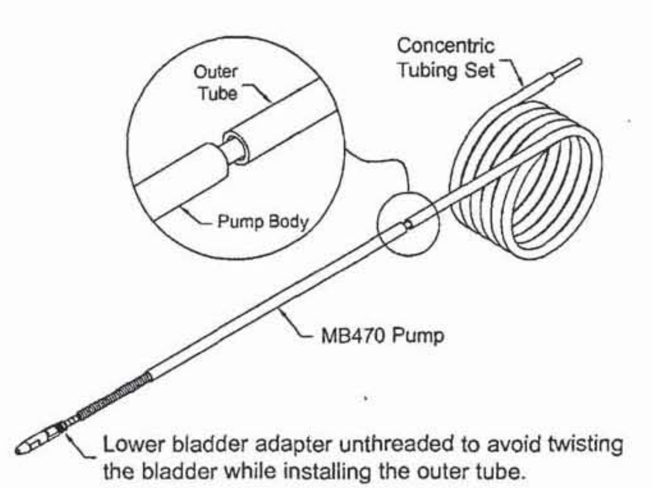


Figure 4.4: Thread the outer tube of the concentric tubing set into the pump body.

NOTE: Friction between the inner and outer tubes may make it difficult to attach the pump with the tubing set coiled. To overcome this problem, attach the pump while the concentric tubing is unrolled in the PVC riser sections as described at the bottom of Page 10.

The user may also choose to lower the concentric tubing set partway down the tool string or well, attach the pump to the exposed end of the tubing, retrieve the tubing set, and install the pump for purging or sampling. If this technique is used, **take great care to avoid dropping the tubing set down the well or tool string during attachment of the pump.**

4.3 Selecting and Installing the Actuator

Operating the mechanical bladder pump requires holding the outer tube of the concentric tubing set stationary while moving the inner tube up-and-down. Although this maneuver is possible by simply holding the outer tube in one hand and moving the inner tube with the other hand, an actuator makes operation of the pump significantly easier.

NOTE: The tubing set must be completely unrolled for the inner tube to slide freely within the outer tube.

This section identifies the available actuator options. Methods by which the actuators attach to the concentric tubing set and are installed on the monitoring well or tool string are also addressed.

Handheld Manual Actuator

The handheld actuator option is the first step above simply grasping the inner and outer tube by hand. With this option, a Hand Grip Assembly (20545) and Outer Tubing Grip (22758) are installed on the concentric tubing set (Fig. 4.5). Sampling or purging is accomplished by physically holding the outer tubing grip in one hand while raising and lowering the hand grip assembly with the other hand. A handheld actuator may be used to purge or collect samples through probe rods from a groundwater sampler as well as from a permanent monitoring well.

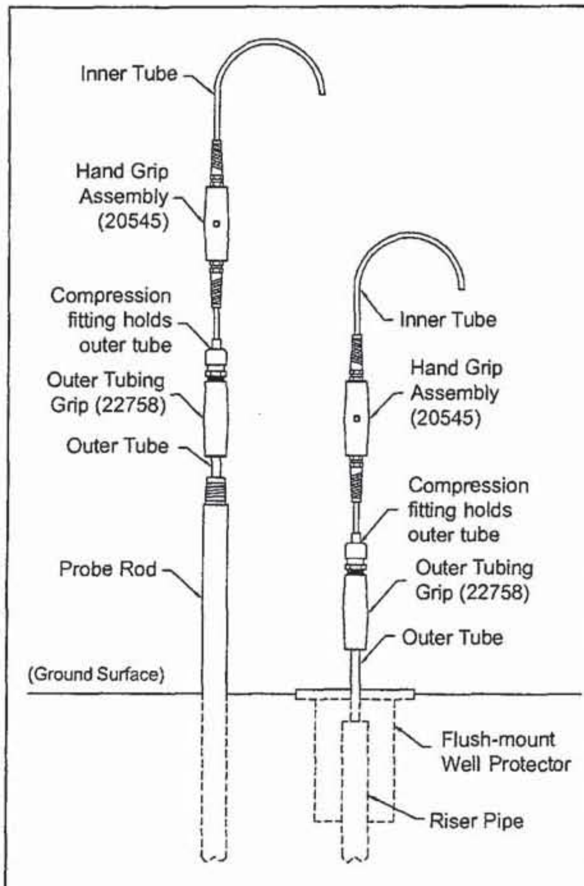


Figure 4.5: Handheld actuator parts for use with groundwater samplers and monitoring wells.

Installation of the handheld actuator is described below.

1. Determine the depth to which the pump inlet will be installed as measured from the top probe rod or riser pipe with a weighted tape or water lever meter.

2. The distance from the pump inlet to the top of the tool string or riser pipe (from Step 1) may now be marked on the outer tube. Obtain an assembled MB470 Mechanical Bladder Pump (Section 4.1) with a concentric tubing set installed as instructed in Section 4.2. Beginning from the pump inlet, measure the appropriate distance along the outer tube and mark it with electrical tape or a suitable marker. The tubing set will be installed such that this mark is aligned with the top of the probe rods or riser.

3. Leading with the end opposite the compression fitting, slide the outer tubing grip over the top end of the tubing set. It may be necessary to loosen the fitting slightly (Fig. 4.6) to allow installation.

4. Position the grip with the lower end even with, or slightly above the line marked on the outer tube in Step 2. The specific location of the grip should be determined by operator preference. The important thing is that the pump inlet is maintained at the appropriate level during sampling as indicated by the mark on the outer tube.

5. Secure the grip to the outer tube by tightening the large nut of the compression fitting (Fig. 4.6) until it is "hand tight". Do not overtighten as this may damage the plastic fitting.

6. Carefully cut off the excess outer tube leaving approximately .25 inches (6 mm) above the compression fitting. (Note that the inner tube is not cut at this location). Now measure and cut the inner tube leaving it approximately 3 feet (1 m) longer than the outer tube.

7. Slide the hand grip assembly over the inner tube and position it 1-2 inches (25-51 mm) above the outer tubing grip as shown in Figure 4.6. It may be necessary to first loosen the two compression fittings to allow installation over the inner tube.

8. Secure the hand grip by tightening the two compression fittings. Take care not to overtighten and damage the fittings. Also avoid kinking the inner tube while completing this step

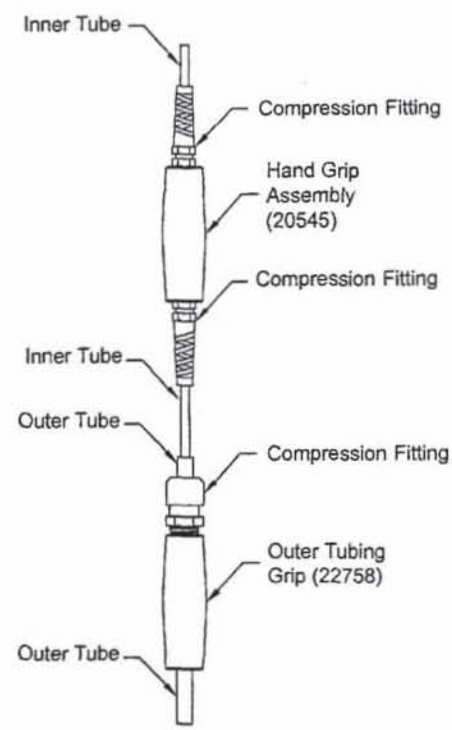


Figure 4.6: Close-up view of hand grip and outer tubing grip.

To operate the mechanical bladder pump with the handheld actuator, simply insert the pump into the probe rod string or monitoring well. Lower the pump and concentric tubing set until the mark on the outer tube (measured and marked previously in Step 2, Page 12) is aligned with the top of the probe rod string or well riser. Initiate pump flow by holding the outer tubing grip stationary with one hand while cycling the hand grip assembly up-and-down with the other hand. A pump stroke of up to approximately 6 inches (150 mm) is recommended.

Anchored Manual Actuator

The anchored actuator option is similar to the handheld actuator in that the mechanical bladder pump is cycled by physically raising and lowering the inner tube using the Hand Grip Assembly (20545). But while the handheld actuator requires a second hand to hold the outer tube, the anchored actuator option utilizes adapters to mechanically secure the outer tubing to the top probe rod or riser pipe as shown in Figure 4.7.

Installation of the mechanical bladder pump with the anchored actuator option is reviewed in this section for both probe rod and well riser applications.

1. The outer tube of the concentric tubing set is connected to the top probe rod or well riser using an Outer Tubing Adapter (20544) plus additional adapters as determined by the size of rod or riser onto which the actuator is to be installed.

   Referring to Table 4.1, select the appropriate adapter(s) for your size of probe rod or well riser. Illustrations and complete descriptions of the various adapters are presented in Table 4.2 and Figures 4.8 - 4.10. Note that .5-inch and 0.75-inch riser pipe each require two PVC adapters in addition to the outer tubing adapter.

2. Assemble the adapters by threading the outer tubing adapter into the probe rod or well riser adapter.

   As illustrated in Figure 4.8, two adapters are required to attach the outer tubing adapter to .5-inch and .75-inch riser pipe. After threading the outer tubing adapter into the 1.0-inch PVC to 1.0-inch NPT Adapter (17558), either a .5-inch PVC adapter (19424) or .75-inch PVC adapter (17559) is then installed in the remaining end of the 1.0-inch PVC adapter.

3. Determine the depth to which the pump inlet will be installed as measured from the top probe rod or riser pipe with a weighted tape or water lever meter.

4. The distance from the pump inlet to the top of the tool string or riser pipe (from Step 3) is now marked on the outer tube:

   Obtain an assembled MB470 Mechanical Bladder Pump (Section 4.1) with a concentric tubing set installed as instructed in Section 4.2. Beginning from the pump inlet, measure the appropriate distance along the outer tube and mark it with electrical tape or a suitable marker. The tubing set will be installed such that this mark is aligned with the top of the probe rods or riser.

5. Slide the assembled adapters (from Step 2) over the top end of the tubing set leading with the end opposite the compression fitting. See Figure 4.7 for adapter orientation. It may be necessary to loosen the compression fitting slightly to allow installation.

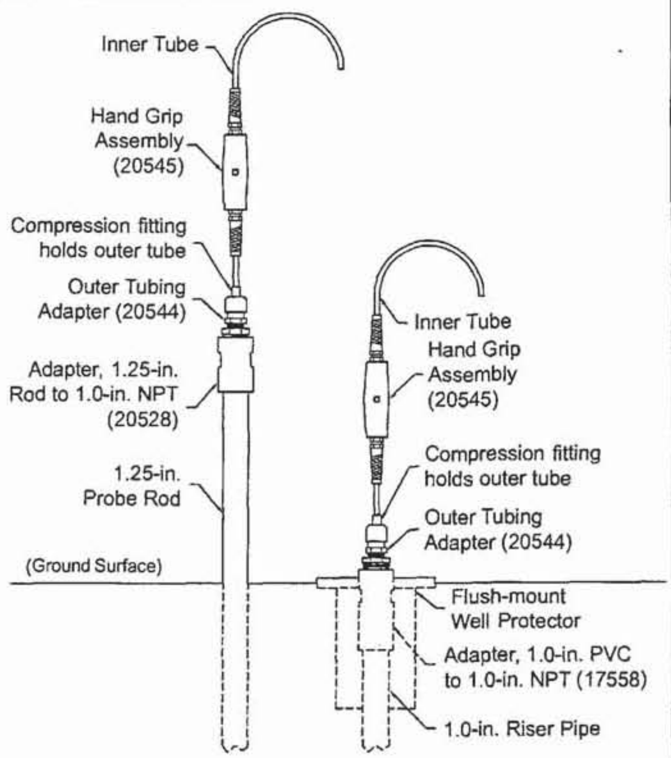


Figure 4.7: Manual actuator parts for use with groundwater samplers and monitoring wells. (Part numbers specified for 1.25-inch probe rods and 1.0-inch riser pipe.)

6. Position the adapters such that the line marked on the outer tube in Step 4 will be even with the top of the probe rod or well riser when the pump is installed on the tool string or riser.

7. Secure the adapters to the outer tube by tightening the large nut of the compression fitting (Fig. 4.7) until it is "hand tight". Do not overtighten as this may damage the plastic fitting.

Size	Probe Rod Adapters	Monitoring Well Riser Adapters
.5-inch	na	17559, 17558, and 20544
.75-inch	na	19424, 17558, and 20544
1.0-inch	20527 and 20544	17558 and 20544
1.25-inch	20528 and 20544	na
1.5-inch	20529 and 20544	na
2.0-inch	na	22759 and 20544

Table 4.1: Part numbers for the adapters required to attach the outer tube to various probe rods and PVC riser pipe.

8. Carefully cut off the excess outer tube leaving approximately .25 inches (6 mm) above the compression fitting. (Note that the inner tube is not cut at this location). Now measure and cut the inner tube leaving it approximately 3 feet (1 m) longer than the outer tube.

9. Slide the hand grip assembly over the inner tube and position it 1-2 inches (25-51 mm) above the outer tubing grip as shown previously in Figure 4.6. It may be necessary to first loosen the two compression fittings to allow installation over the inner tube.

10. Secure the hand grip by tightening the two compression fittings until they are hand tight. Do not overtighten the plastic fittings as damage may result.

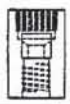
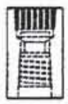
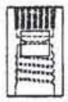
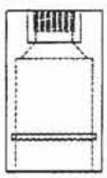
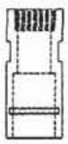
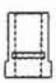
Illustration	Part Number	Description
	20544	Outer Tubing Adapter
	20527	Adapter, 1.0-in. probe rod pin to 1.0-in. NPT pin
	20528	Adapter, 1.25-in. probe rod pin to 1.0-in. NPT pin
	20529	Adapter, 1.5-in. probe rod pin to 1.0-in. NPT pin
	22759	Adapter, 2.0-in. PVC to 1.0-in. NPT Pin
	17558	Adapter, 1.0-in. PVC to 1.0-in. NPT Pin
	19424	Adapter, .75-in. PVC to 17558 Adapter
	17559	Adapter, .5-in. PVC to 17558 Adapter

Table 4.2: Adapters for attaching the outer tube to probe rods and PVC riser pipe.

11. Lower the mechanical bladder pump down the probe rods or well riser. Secure the outer tubing adapter by threading it onto the top probe rod or sliding it over the top of the well riser.

    The mechanical bladder pump is now ready for purging and/or sampling.

Operation of the mechanical bladder pump with a manual actuator is limited to simply raising and lowering the hand grip assembly using a stroke length up to 6 inches (152 mm). This action extends and retracts the pump bladder to push formation fluid to the ground surface through the inner tube of the concentric tubing set. The outer tube is attached to the probe rod string or well riser by adapters and is thus held stationary while the pump is actuated.

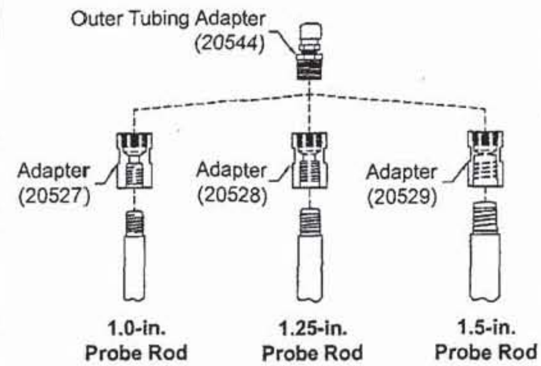


Figure 4.8: Adapters for attaching the outer tube to 1.0-, 1.25-, and 1.5-inch probe rods.

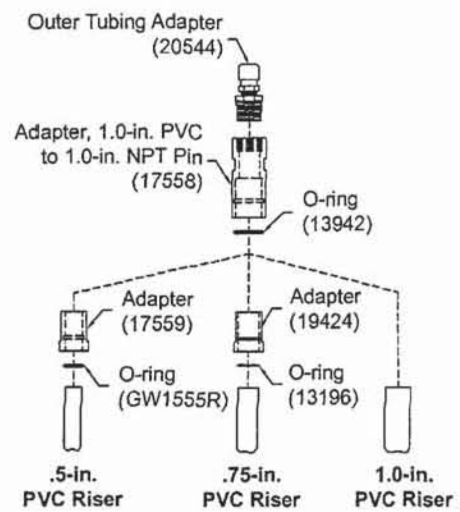


Figure 4.9: Adapters for attaching the outer tube to .5-, .75-, and 1.0-inch PVC riser pipe.

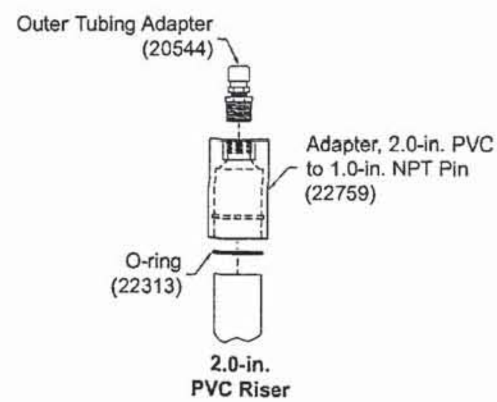


Figure 4.10: Adapters for attaching the outer tube to 2.0-inch PVC riser pipe.

Mechanical Actuator

The third actuator option for the MB470 Mechanical Bladder Pump is a Mechanical Actuator Assembly (MB6000, Figure 4.10). Rather than physically raising and lowering the inner tube to cycle the pump, the operator simply rotates the handle on the side of mechanical actuator. The actuator assembly converts this rotational action to vertical movement of the inner tube which cycles the pump. The operator may also choose to manually raise and lower the inner tube by disconnecting the side handle and utilizing the T-handle at the top of the assembly.

An advantage of the mechanical actuator option is that it requires little physical input to operate the pump. This translates to minimal operator fatigue when purging or sampling from multiple wells during the day.

The mechanical actuator assembly may be installed directly on a probe rod string (Fig. 4.10) or attached to a flush-mount or aboveground well protector using a Well Mount Kit (MB7200) as shown in Figures 4.11 and 4.12. Installation and operation of the mechanical actuator are described below.

1. Determine the depth to which the pump inlet will be installed as measured from the top of the probe rods or well protector with a weighted tape or water level meter.

2. The distance from the pump inlet to the top of the tool string or well protector (from Step 1) may now be marked on the outer tube:

   Obtain an assembled MB470 Mechanical Bladder Pump (Section 4.1) with a concentric tubing set installed as instructed in Section 4.2. Beginning from the pump inlet, measure the appropriate distance along the outer tube and mark it with electrical tape or a suitable marker. The tubing set will be installed such that this mark is aligned with the top of the probe rods or well protector.

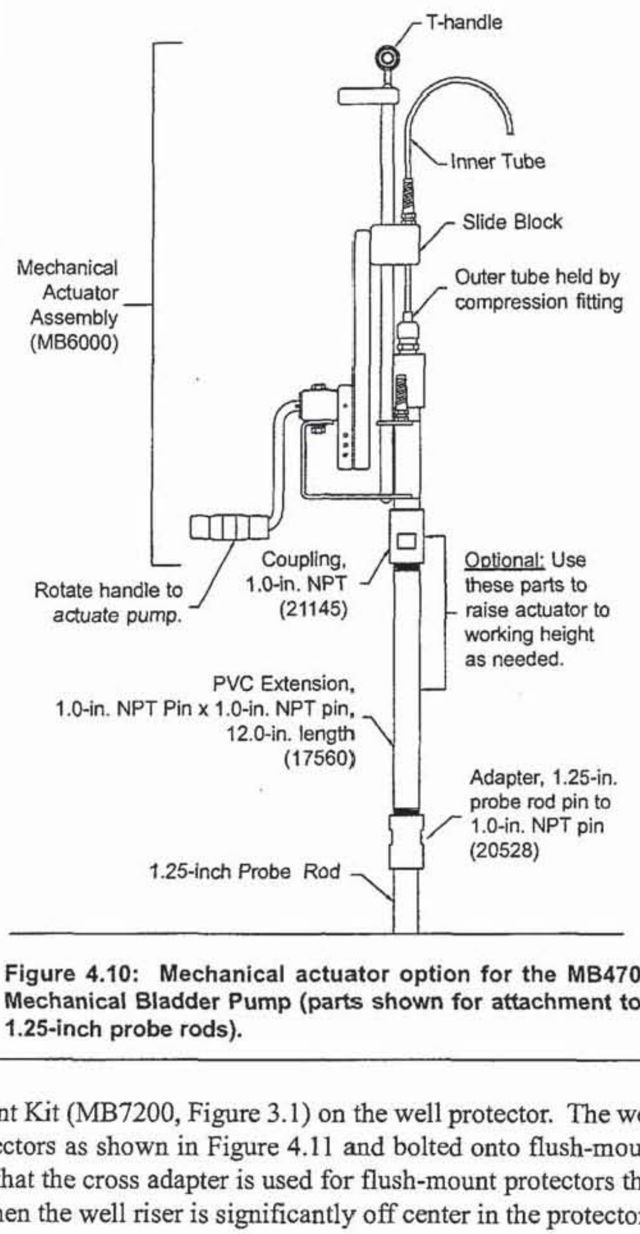


Figure 4.10: Mechanical actuator option for the MB470 Mechanical Bladder Pump (parts shown for attachment to 1.25-inch probe rods).

3. ***For monitoring wells only:*** Install a Well Mount Kit (MB7200, Figure 3.1) on the well protector. The well mount is strapped onto aboveground well protectors as shown in Figure 4.11 and bolted onto flush-mount well protectors as shown in Figure 4.12. Note that the cross adapter is used for flush-mount protectors that utilize three bolts on the cover (Fig. 4.12) or when the well riser is significantly off center in the protector.

4. Lower the pump and concentric tubing set down the probe rod string or through the well mount into the riser pipe. Stop when the mark on the outer tube (from Step 2) is near the top of the probe rods or well protector.

5. ***For probe rods only:*** Referring to Table 4.2, select the appropriate Probe Rod Pin to 1.0-inch NPT Pin Adapter (20527, 20528, or 20529) to attach the actuator to the top probe rod. Thread this adapter (and a 12-inch extension if additional height is needed) into the actuator as shown on the completed assembly in Figure 4.10.

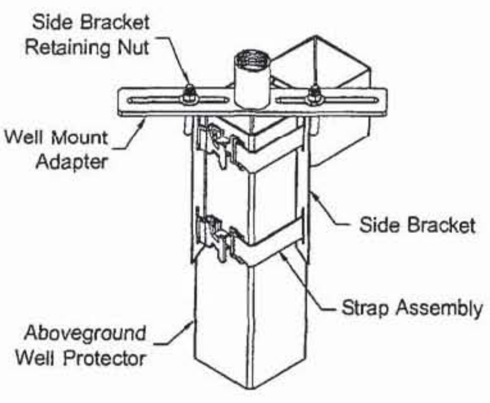


Figure 4.11: Well Mount Kit installed on an aboveground well protector. (Kit may also be used with round protectors.)

6. Insert the top end of the concentric tubing set through the lower end of the mechanical actuator assembly. Feed the tubing set through the actuator and out the compression fitting identified in Figure 4.10.

   For probe rods only: The mark on the outer tube (Step 2) will not be visible once the actuator is installed on the probe rods. To allow for this, position the tubing within the actuator such that the mark will be at the top of the rods when the actuator is installed. Now mark the outer tube at the compression fitting of the actuator assembly for reference later in the installation procedure.

7. Thread the mechanical actuator onto the top probe rod or well mount until all connections are hand tight.

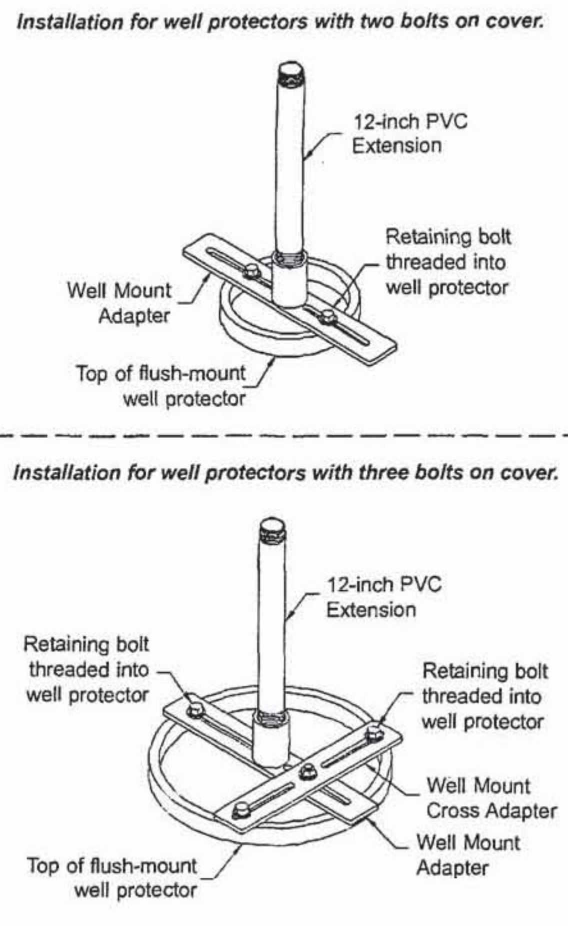


Figure 4.12: Well Mount Kit installed on flush-mount well protectors with 2- and 3-bolt patterns on cover.

8. Verify the position of the outer tube by observing the mark placed on the tube in Step 2 or 6. Tighten the compression fitting (hand tight) to secure the tubing. Do not overtighten as this may damage the fitting.

9. Carefully cut off the excess outer tube leaving approximately .25 inches (6 mm) above the compression fitting. (Note that the inner tube is not cut at this location).

10. Taking care not to kink the inner tube, insert the inner tube up through the compression fitting on the actuator slide block (see Fig. 4.10 for identification of slide block). It may help to raise the slide block during this step.

    With the slide block fully lowered, gently pull up on the inner tube to remove slack. Do not pull so far that the pump spring is compressed. Tighten the compression fitting to secure the inner tube. Again, do not overtighten as this may damage the plastic fitting.

11. Cut the inner tube leaving it approximately 3 feet (1 m) longer than the outer tube. You may choose to insert the end of the inner tube through the top of the compression fitting on the side of the actuator. This will limit movement of the tube outlet while operating the pump

    The mechanical bladder pump is ready for operation by rotating the side handle of the mechanical actuator or disconnecting the side handle linkage and manually raising and lowering the T-handle.

4.4 Purging and Sampling

The MB470 Mechanical Bladder pump was designed to provide an economical and efficient method to conduct the low flow sampling protocol (Puls and Barcelona 1996, ASTM 2003), Nielsen and Nielsen 2002). The basis of this protocol is that a sampling flow rate of 500 ml/min or less for 2-inch wells (100 to 200 ml/min for smaller diameter direct push wells) generally provides a sample of higher quality that is more representative than sampling at high flow rates (e.g. several liters or gallons per minute). Higher quality samples for volatile organic compounds are obtained because the water being sampled is subjected to less physical and chemical stress so that loss of these analytes does not occur. Additionally, higher quality samples for inorganic analytes (e.g. lead, hexavalent chromium, etc.) are obtained because the low flow sampling method minimizes turbidity that can cause significant bias for these sensitive analytes.

To obtain the most representative samples, the monitoring well or temporary groundwater sampler should be developed before sampling is conducted. Development may consist of simple surging and purging with an inertial pump for temporary samplers depending on the data quality objectives (Geoprobe® 2002). However, more elaborate methods may be required for some monitoring wells (ASTM 2001).

To meet the full requirements of the low flow sampling protocol, field parameters of the pre-sample purge water (temperature, pH, specific conductance, ORP, DO, and turbidity) should be monitored using an in-line flow cell. Once these parameters have stabilized, the samples are then collected in clean, preserved sample containers appropriate for the analytes of concern. Pre-sample purging may be completed in as little as 10 to 20 minutes in adequately developed small-diameter wells with as little as 5 to 10 liters of water generated. In larger diameter wells that have not been adequately developed, a significantly longer purge time and volume may be required.

4.5 Decontaminating the Pump

Decontamination of the pump may be performed in two general ways. For the highest integrity samples the pump should be fully disassembled for thorough decontamination (decon) and the bladder and O-rings replaced. If the pump is being used as a portable pump for sampling multiple locations daily, the pump may be decontaminated while assembled. Review and understand the sampling and data quality objectives for your project before selecting the appropriate decontamination procedure . (For further information on data quality objectives see EPA 1997, or Geoprobe® 2002). The concentric tubing set should be replaced between each sampling location to minimize the potential for cross contamination. If possible, sample from background or low concentration wells to higher concentration wells to minimize the chance for cross contamination.

Disassemble for Decontamination

Simply reverse the procedures described in Section 4.1 to disassemble the pump and concentric tubing set. Place the disassembled pump in a clean beaker or small bucket of water. Use distilled water for highest level of decon. Add Alconox soap (or similar cleaning agent) to the water. Thoroughly clean and brush all inside and outside surfaces. The MBP Cleaning Brush Kit (MB7300) includes four small-diameter brushes selected specifically to clean inside the various pump components. Double rinse all parts with distilled or deionized (DI) water and allow to air dry. Reassemble the pump using a new bladder and O-rings.

Review ASTM Practice D5088 for further guidance and detail on decon procedures. Additional decontamination may be obtained by drying the disassembled pump in a clean drying oven at about 95°C (203°F). This will provide additional assurance that volatile contaminants are removed from pump surfaces.

Decontamination of Assembled Pump

While this method will not provide the assurance of the highest quality samples it may be preferred when lower sample quality is acceptable (For further information on data quality objectives see EPA 1997, or Geoprobe® 2002). When initial site assessments are conducted it is often desirable to obtain many samples at a reasonably modest cost so as to adequately characterize a site. This decon procedure will help reduce the per sample cost while providing acceptable sample quality for many site assessments.

Remove the concentric tubing set from the pump and discard. Submerge the pump in clean soapy water and pump several volumes of water through the pump. Thoroughly wash the exterior of the pump removing all visible dirt or stains. Rinse and transfer the pump to a container of clean tap water or deionized water. Again pump multiple volumes of water through the pump and wash the pump exterior to remove all soap. A second rinse is recommended. Allow the pump to air dry. Again, drying the fully assembled pump in a clean drying oven at about 95°C (203°F) will further remove any volatiles from pump surfaces.

Rinsate Samples

Regularly collect rinsate samples from the pump following decontamination and submit the samples for analysis for the analytes of concern . This will provide another level of quality control and assurance that samples meet the site-specific data quality objectives. Pump clean distilled water through the pump and collect the fluid in an appropriate preserved container. Store, ship and handle rinsate samples in the same manner as field samples.

5.0 REFERENCES

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Puls, Robert W., and Michael J. Barcelona, 1996. Ground Water Issue: Low-Flow (Minimal Drawdown) Ground Water Sampling Procedures. EPA/540/S-95/504. April.

Equipment and tool specifications, including weights, dimensions, materials, and operating specifications included in this brochure are subject to change without notice. Where specifications are critical to your application, please consult Geoprobe Systems®.

Geoprobe® Systems

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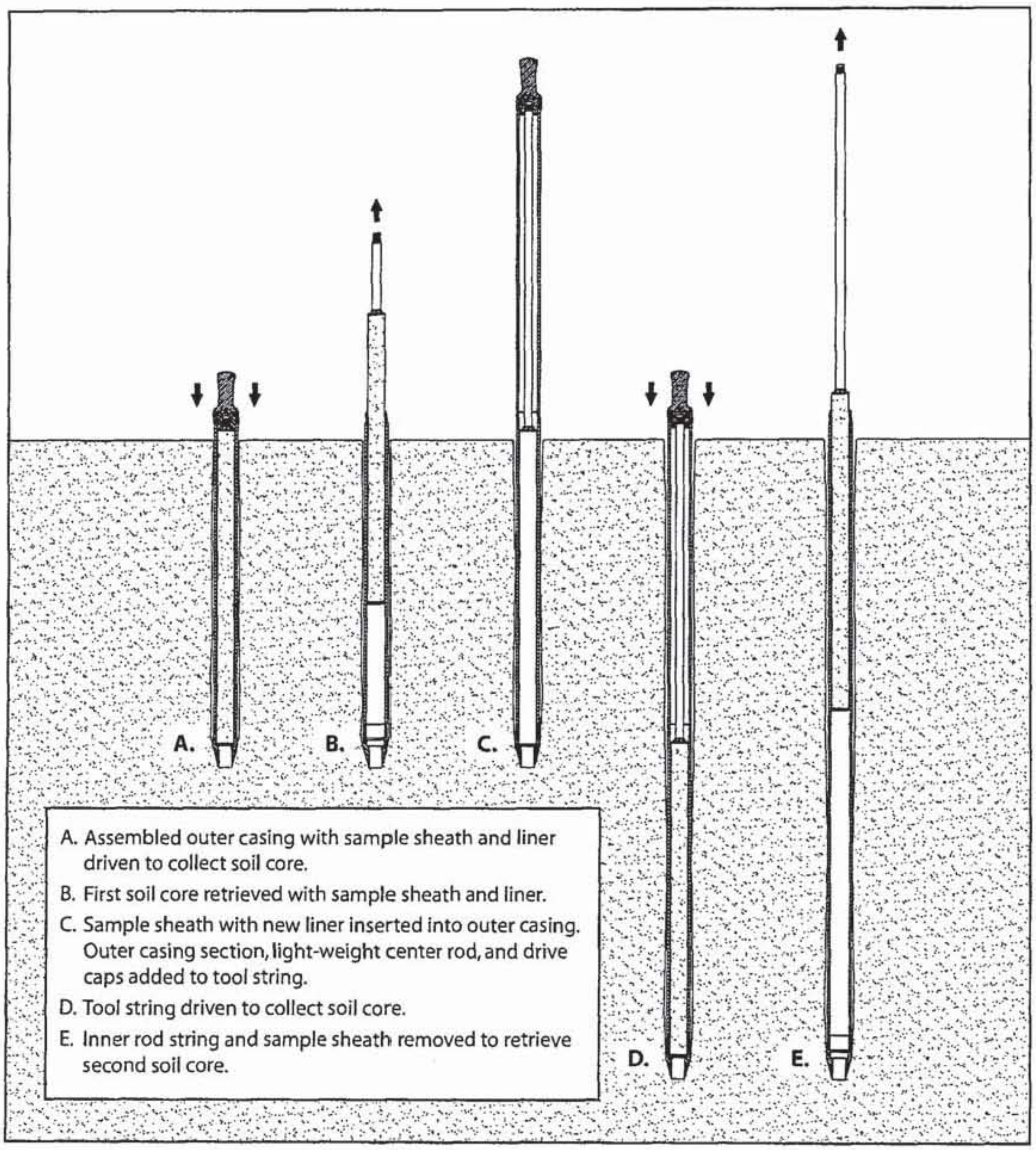
GEOPROBE® DT325 DUAL TUBE SAMPLING SYSTEM

STANDARD OPERATING PROCEDURE

Technical Bulletin No. MK3138

PREPARED: November, 2006
REVISED: July, 2010



Collecting soil cores with the DT325 Dual Tube Sampling System.

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Geoprobe® Prepacked Screens are manufactured under
U.S. Patent No. 7,735,553B2.

1.0 Objective

The objective of this procedure is to collect a representative soil sample at depth through an enclosed casing and recover it for visual inspection and/or chemical analysis.

2.0 Background

2.1 Definitions

Geoprobe®*: A brand name of high quality, hydraulically-powered machines that utilize both static force and percussion to advance sampling and logging tools into the subsurface. The Geoprobe® brand name refers to both machines and tools manufactured by Geoprobe Systems®, Salina, Kansas. Geoprobe® tools are used to perform soil core and soil gas sampling, groundwater sampling and testing, soil conductivity and contaminant logging, grouting, and materials injection.

**Geoprobe® and Geoprobe Systems® are registered trademarks of Kejr, Inc., Salina, Kansas.*

DT325 Dual Tube Sampling System: A direct push system for collecting continuous core samples of unconsolidated materials from within a sealed casing of Geoprobe® 3.25-inch (83 mm) OD probe rods. Samples are collected and retrieved within a sample sheath and liner that is threaded onto the leading end of a string of Geoprobe® 1.25-inch (32 mm) OD light-weight center rods and inserted to the bottom of the outer casing. Collected samples measure up to approximately 2,600 ml in volume in the form of a 1.85-inch x 59-inch (47 mm x 1499 mm) core when using common equipment options.

Liner: A 2.1-inch (53 mm) OD thin-walled, PVC tube that is placed within a steel sheath and then inserted into the outer casing on the leading end of the inner rod string for the purpose of containing and retrieving core samples. Liners are available in two configurations; a simple open tube or a tube with a core catcher permanently attached to the leading end. Nominal liner lengths include 1 meter, 48 inches, and 60 inches.

***Nominal liner length identifies the length of tools with which the liner is used. The actual end-to-end lengths of the various DT325 liners will differ from the specified nominal lengths.*

Core Catcher: A dome-shaped device positioned at the leading end of a liner to prevent loss of collected soil during retrieval of the liner and soil core. Flexible fingers at the top of the core catcher are pushed outward by soil entering the liner during advancement of the tool string. As the filled liner is subsequently retrieved, the fingers of the core catcher move back inward, effectively closing off the end of the liner and limiting soil loss. The core catcher designed for the DT325 system is permanently fused to the liner.

2.2 Discussion

Dual tube sampling gets its name from the fact that two sets of probe rods are used to retrieve continuous soil core samples from the subsurface. One set of rods is driven into the ground as an outer casing (Fig. 2.1). These rods receive the driving force from the hammer and provide a sealed casing through which soil samples may be recovered. The second, smaller set of rods are placed inside the outer casing with a sample liner attached to the leading end of the rod string (Fig. 2.1). These smaller rods hold the liner in place as the outer casing is driven to fill the liner with soil. The inner rods are then retracted to retrieve the full liner.

Standard Geoprobe® 3.25-inch OD probe rods provide the outer casing for the DT325 Dual Tube Soil Sampling System. A cutting shoe is threaded into the leading end of the rod string. When driven into the subsurface, the cutting shoe shears a 1.75- or 1.85-inch OD soil core (depending on cutting shoe option) which is collected inside the casing in a PVC liner.

The second set of rods in the DT325 dual tube system are Geoprobe® 1.25-inch OD light-weight center rods. A sample sheath with PVC liner is attached to the end of these smaller rods and then inserted into the casing. The 1.25-inch light-weight center rods hold the sample sheath tight against the cutting shoe as the outer casing is driven to collect the soil core. Once filled with soil, the sample sheath and liner are removed from the bottom of the outer casing by lifting out the 1.25-inch center rod string.

The outer, 3.25-inch probe rods provide a cased hole through which to sample. The main advantage of sampling through a cased hole is that there is no side slough to contend with. In addition, the outer casing effectively seals the probe hole when sampling through perched water tables. These factors mean that sample cross-contamination is eliminated. The DT325 sampling system is therefore ideal for continuous coring in both saturated and unsaturated zones.

Solid Drive Tip

A Solid Drive Tip (28509 or 27763) can be placed on the leading end of the inner 1.25-inch rod string in place of a sample sheath and liner (Fig. 2.2). When installed in the outer casing, the drive tip firmly seats within the cutting shoe and effectively seals the tool string as it is driven into the subsurface. This enables the operator to advance the outer casing to the bottom of a pre-cored hole or through undisturbed soil to reach the top of the sampling interval.

Grouting

The DT325 system allows bottom-up grouting through the primary tool string. This means that a cement or bentonite grout mix can be pumped through the outer casing as it is withdrawn from the ground. This is in contrast to most other soil samplers which require driving a second set of tools back down the probe hole in order to deliver the grout mix.

Monitoring Well Installation

An expendable cutting shoe enables the operator to install a Geoprobe® prepacked screen monitoring well through the outer casing of the DT325 Dual Tube System. After the collection of continuous soil cores to the desired depth, prepacked screens can be inserted to the bottom of the outer casing on the leading end of a PVC riser string. The well is finished, complete with grout barrier, bentonite well seal, and a high-solids bentonite slurry/neat cement grout, during retrieval of the outer casing.

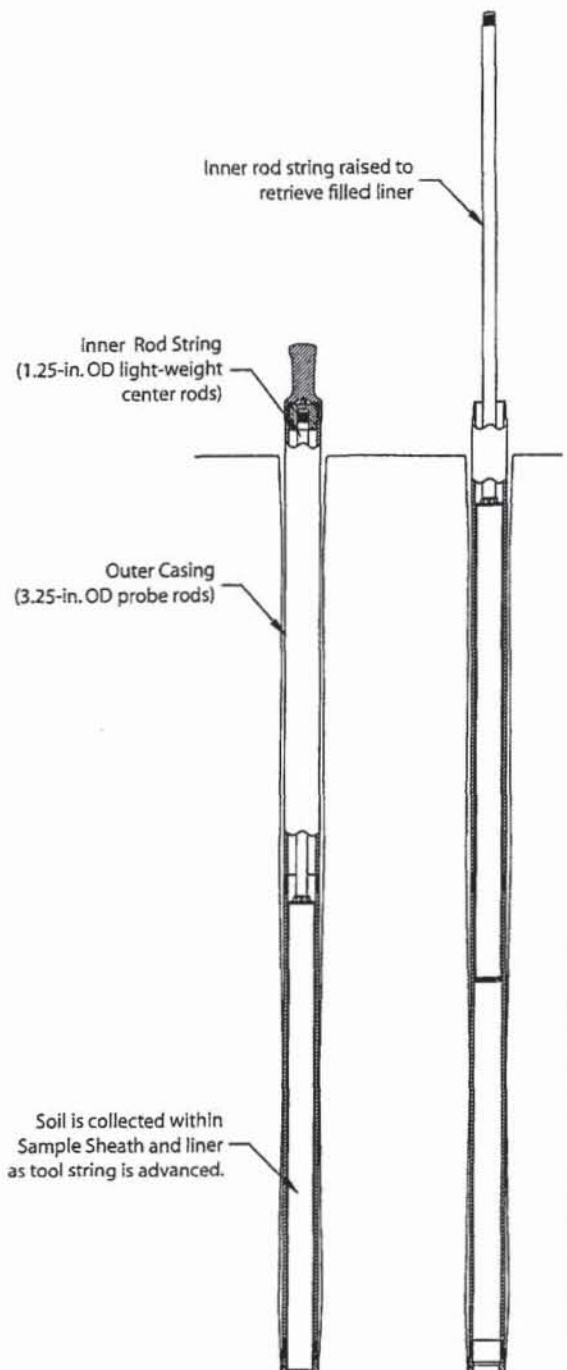

Figure 2.1
Outer casing driven with sample sheath and liner.

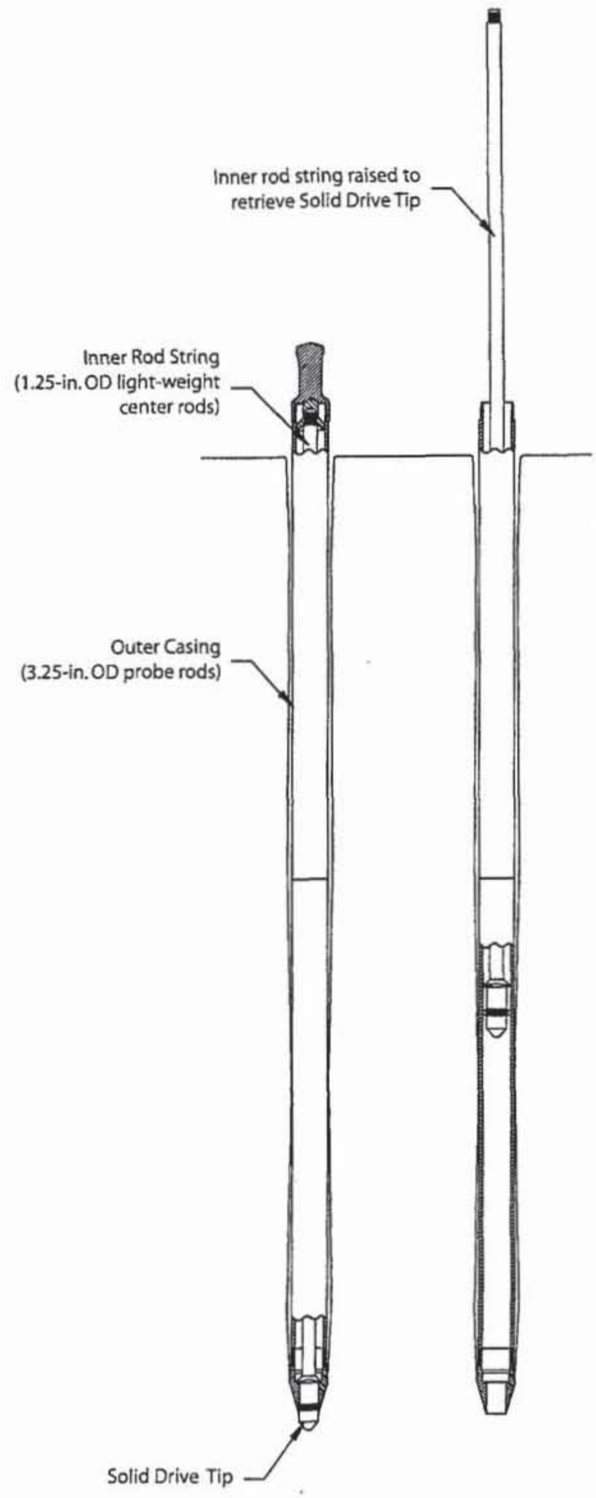

Figure 2.2
Outer casing driven with solid drive tip.

3.0 Tools and Equipment

The following equipment is required to operate the DT325 DualTube Sampling System. Refer to Figure 3.1 for identification of the specified parts.

DT325 Sampler Parts*	Quantity	Part Number
DT325 Sheath Drive Head	-1-	10212
DT325 Sample Sheath, 72-in. length	-1-	26805
DT325 Sample Sheath, 60-in. length	-1-	26719
DT325 Sample Sheath, 48-in. length	-1-	27711
DT325 Sample Sheath, 1-m length	-1-	27712
DT325 Centering Drive Cap, 1.25-in. rods	-1-	12943
DT325 Buffering Centering Drive Cap, 1.25-in rods	-1-	37708
DT325 Cutting Shoe, standard, 1.85-in. ID	-1-	28508
DT325 Cutting Shoe, optional, 1.75-in. ID	-1-	26720
DT325 Expendable Cutting Shoe Holder	-1-	28339
DT325 Expendable Cutting Shoe, 1.75-in. ID	-1-	28341
DT325 Solid Drive Tip, for standard (28508) cutting shoe	-1-	28509
DT325 Solid Drive Tip, for optional cutting shoe (28341) and expendable cutting shoe (26720)	-1-	27763
Replacement O-rings, for DT325 solid drive tips (28509 and 27763), pkg. of 25	Variable	13942
DT325 Liner Retainer	-1-	26718
O-rings, for DT325 liner retainer (26718), pkg. of 25	Variable	28379
DT325 Liner Retainer, without O-ring groove	-1-	39011
DT325 Liner Retainer Wrench	-1-	27838

DT325 Liners and Accessories	Quantity	Part Number
DT325 Liner Spacer	Variable	29609
DT325 Liner Spacer Head	-1-	29358
DT325 PVC Liner, 60-in. length, box of 43	Variable	DT3260K
DT325 PVC Liner, 48-in. length, box of 43	Variable	DT3248K
DT325 PVC Liner, 1-m length, box of 43	Variable	DT3239K
DT325 PVC Liner with Core Catcher, 60-in. length, box of 43	Variable	27813
DT325 PVC Liner with Core Catcher, 48-in. length, box of 43	Variable	27814
DT325 PVC Liner with Core Catcher, 1-m length, box of 43	Variable	27815
DT325 Vinyl End Caps, pkg. of 84 (42 pair)	Variable	17762
DT325 Liner Cutter	-1-	26155
Universal Liner Holder	-1-	22734

Probe Rods and Accessories*	Quantity	Part Number
GH60 Threadless Drive Cap, 3.25-in. rods**	-1-	9742
Pull Cap, 3.25-in. rods	-1-	13257
Rod Grip Handle, GH60 Hammer, 3.25-in. rods	-1-	9757
Probe Rod, 3.25-in. OD x 60-in. length	Variable	9040
Probe Rod, 3.25-in. OD x 48-in. length	Variable	10594
Probe Rod, 3.25-in. OD x 1-m length	Variable	13925
Replacement O-rings, for 3.25-in. probe rods, pkg. of 25	Variable	9960
Pull Cap, 1.25-in. rods	-1-	AT1204
Rod Grip Handle, GH60 Hammer, 1.5-in. and 1.25-in. rods	-1-	15554
Light-Weight Center Rod, 1.25-in. OD x 60-in. Length***	Variable	27600
Light-Weight Center Rod, 1.25-in. OD x 48-in. Length***	Variable	21900
Light-Weight Center Rod, 1.25-in. OD x 1-meter Length***	Variable	32318
1.25-inch Leaf Puller	-1-	31499
Adjustable Rod Clamp	-1-	27216

Optional Accessories	Quantity	Part Number
DT325 Adapter for Hydraulic Liner Extruder	-1-	24959
DT325 Plunger for Hydraulic Liner Extruder	-1-	23977
Rod Wiper Donuts, 3.25-in. Rods	-1-	27194
Rod Wiper Weldment	-1-	23633

* Select DT325 Sample Sheath and liner lengths to match length of probe rods.
** A 3.25-inch probe rod drive cap is also available for use with GH40 Series hammers.
*** 1.25-inch OD probe rods may be substituted for Light-Weight Center Rods.

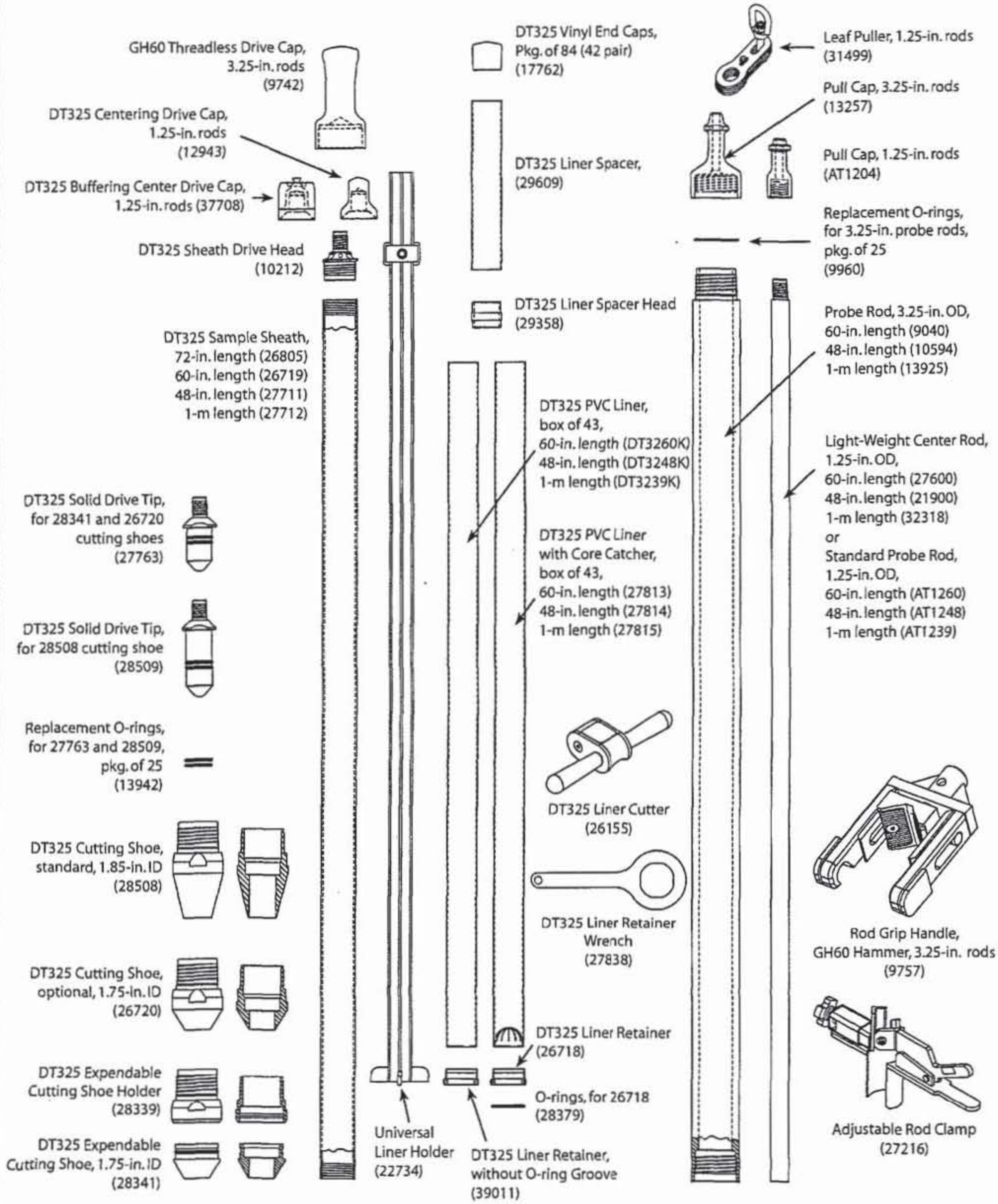

Figure 3.1
DT325 parts and accessories.

3.1 Tool Options

This section identifies the specific tool options available for use with the DT325 Dual Tube System. Refer to Figure 3.1 for illustrations of the specified parts.

Probe Rods

Standard Geoprobe® 3.25-inch (83-mm) OD probe rods are utilized for the outer casing of the DT325 Sampling System. Nominal rod lengths include 1 meter, 48 inches, and 60 inches. The specific length of rods may be selected by the operator and will determine the length of tooling for the rest of the DT325 system.

1.25-inch Light-Weight Center Rods

1.25-inch Light-weight center rods (1.25-inch / 32-mm OD) are recommended for the inner rod string of the DT325 system when utilizing an outer casing of 48- or 60-inch long rods. Choose the light-weight rod length that matches the length of rods used for the outer casing (48-inch light-weight rods with 48-inch outer casing, etc.).

A weight reduction of up to 64% is provided by the 1.25-inch light-weight center rods over standard 1.25-inch probe rods. As a result, considerably less energy is expended when retrieving the light-weight center rods from within the outer casing during operation of the DT325 Dual Tube System.

Sample Sheaths

A steel sample sheath supports the weight of the inner rods to protect the sample liner from damage while advancing the DT325 tool string. The liner is placed within the sheath and secured with a drive head at the top of the sheath and a liner retainer at the bottom. The assembled sheath with liner is inserted to the bottom of the outer casing on the leading end of the inner rod string (light-weight rods). After advancing the entire tool string one sample interval, the inner rods and sample sheath are retrieved to recover the soil core.

Sample sheaths are available in nominal lengths of 1 meter, 48 inches, 60 inches, and 72 inches. Sample sheath length is generally matched to the length of the probe rods selected for the outer casing. However, a DT325 Liner Spacer (29609) and DT325 Liner Spacer Head (29358) allow use of 48-inch liners with a 60-inch Sample Sheath (26719) and 60-inch liners with a 72-inch Sample Sheath (26805).

Sample Liners

Sample liners are made of a heavy-duty clear PVC for convenient inspection of the soil sample. Liners are available either as a simple, open tube or with an intergral core catcher. Utilize the core catcher liners when sampling flowing sands, noncohesive soils, extremely dry soils, or any other materials that fall from the liner during retrieval.

Nominal liner lengths include 1 meter, 48 inches, and 60 inches with an OD of 2.1 inches (53 mm). Under "normal" sampling conditions, liner length should correspond to the length of probe rods used for the outer casing. Certain sampling conditions can cause over-filled liners which may lead to problems removing the liner and soil core from the sample sheath. For these special conditions, utilize a Liner Spacer (29609) and DT325 Liner Spacer Head (29358) to provide additional room above the liner for the excess soil (Fig. 3.2). The liner spacer and liner spacer head must be used with either a 48-inch liner in a 60-inch Sample Sheath (26719) or a 60-inch liner in a 72-inch Sampler Sheath (26805). With the tool string only advanced the length of the liner, the liner spacer remains free to accept excess soil that may otherwise overfill the liner.

Cutting Shoes

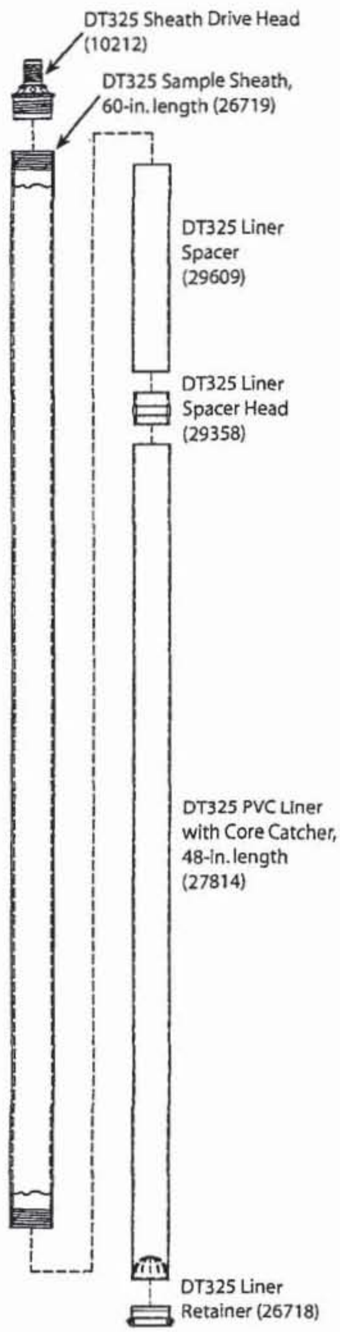

Figure 3.2
Common tooling configuration for use of DT325 Liner Spacer.

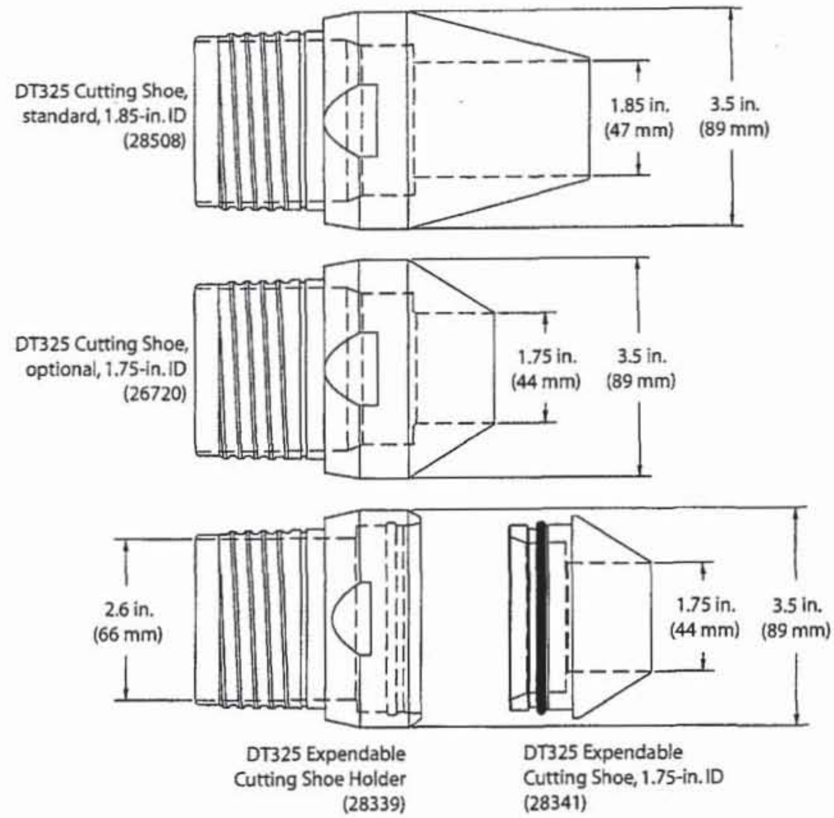

Figure 3.3
Cutting shoe options for the DT325 Dual Tube Sampling System.

Three cutting shoes are available for use with the DT325 Dual Tube System (Fig. 3.3). The DT325 Standard Cutting Shoe (28508) and DT325 Optional Cutting Shoe (26720) thread into the leading end of the 3.25-inch probe rods and are recovered after sampling. Dimensions for the standard cutting shoe are 1.85 inches (47 mm) ID and 3.5 inches (89 mm) OD. The optional cutting shoe also has an OD of 3.5 inches (89 mm), but the ID is only 1.75 inches (44 mm). The standard cutting shoe is ideal for sampling plastic clays and saturated sands while the optional cutting shoe is designed for use in formations where a smaller-diameter soil core is beneficial to sample recovery.

The DT325 sampling system may also employ an expendable cutting shoe (Fig. 3.3). In this arrangement, a DT325 Expendable Cutting Shoe Holder (28339) is threaded into the leading end of the outer casing. A DT325 Expendable Cutting Shoe (28341) is then inserted into the holder. Upon completion of soil sampling, the outer casing is withdrawn slightly. The expendable cutting shoe is knocked from the holder, leaving an open casing through which a prepacked screen monitoring well may be installed. Dimensions for the expendable cutting shoe are the same as the optional cutting shoe (ID = 1.75 in. (44 mm) and OD = 3.5 in. (89 mm)).

4.0 Operation

4.1 Decontamination

Before and after each use, thoroughly clean all parts of the soil sampling system according to project requirements. Parts should also be inspected for wear or damage at this time. During sampling, a clean new liner is used for each soil core.

4.2 Operational Overview

The DT325 Soil Sampling System is designed to collect continuous soil cores. Sampling may begin either from ground surface or a predetermined depth below ground. Once sampling begins, consecutive soil cores are removed as the outer casing is advanced to greater depths

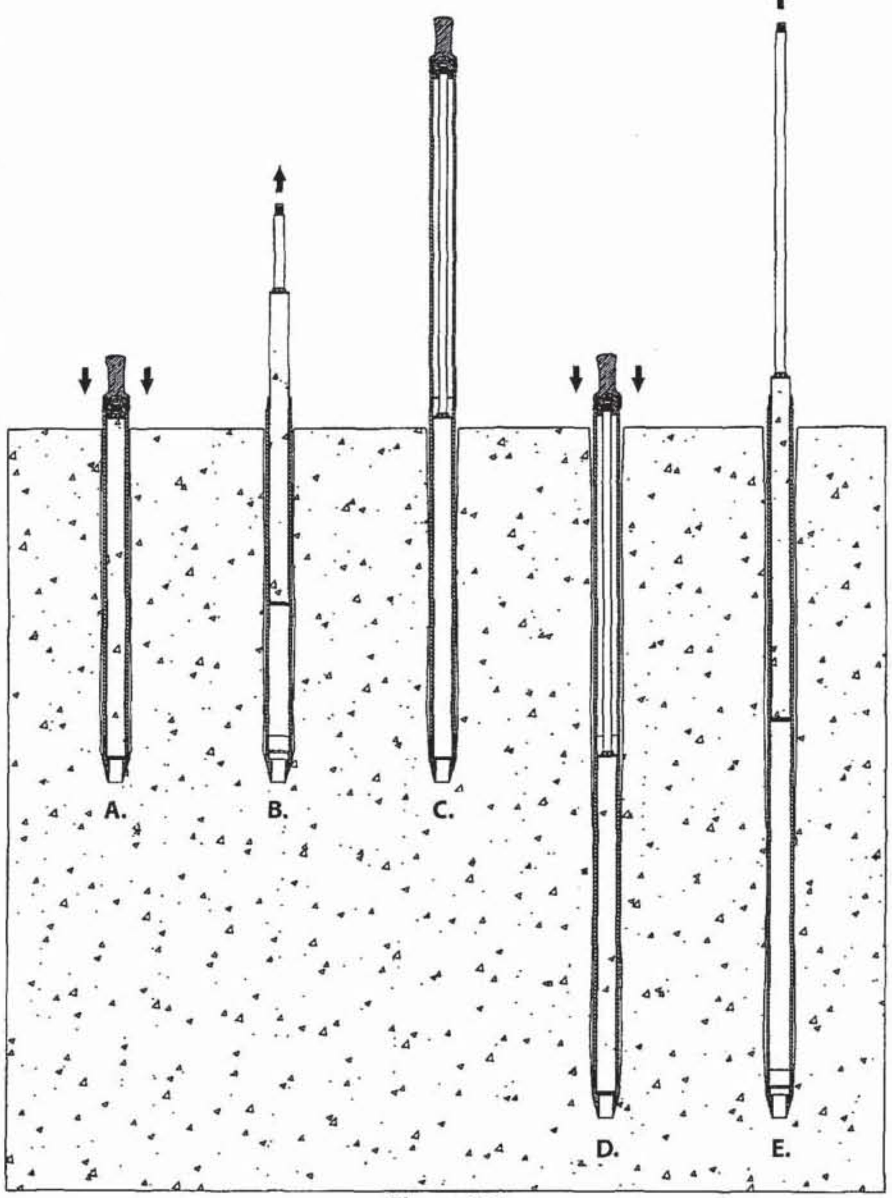

Figure 4.1
Continuous core sampling from ground surface with the DT325 system.

When sampling is to begin at the ground surface, the first soil core is generally collected using a liner with core catcher to maximize sample recovery (Fig. 4.1-A). This is especially true when the first core is composed of dry, loose soil. Upon retrieval of the first liner and soil core (Fig. 4.1-B), a new liner is loaded into the sample sheath and inserted to the bottom of the outer casing on the end of an inner rod. A section of outer casing is added to the tool string (Fig. 4.1-C) and the entire tool string is driven to fill the liner with soil (Fig. 4.1-D). The sample sheath and filled liner are removed from the outer casing to retrieve the second soil core (Fig. 4.1-E). A new liner is placed in the sample sheath and the process is repeated for the entire sampling interval.

When the sampling interval begins at some depth below ground surface, a DT325 Solid Drive Tip is installed in the outer casing and the entire assembly is driven from ground surface directly through undisturbed soil using the DT325 Centering Drive Cap (12943) (Fig. 4.2-A). This enables the operator to reach the top of the sampling interval without stopping to remove unwanted soil cores. Once the interval is reached, the solid drive tip is removed (Fig 4.2-B) and sampling continues using the Buffering Center Drive Cap (37708) as described in the preceding paragraphs (Fig. 4.2-C, Fig. 4.2-D, and Fig. 4.2-E).

Specific instructions for assembly and operation of the DT325 Sampling System are given in the following sections.

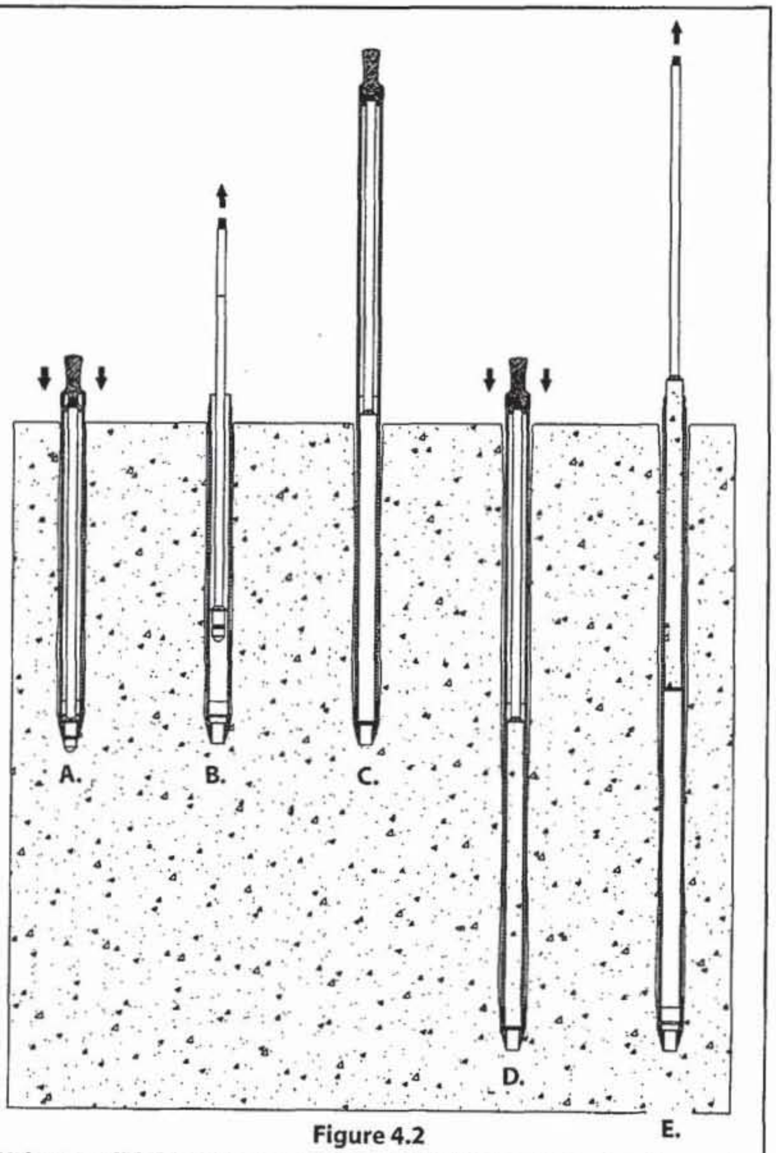

Figure 4.2
Using a solid drive tip to advance the DT325 outer casing through undisturbed soil before collecing soil cores.

4.3 Assembling and Driving the Outer Casing Using a DT325 Solid Drive Tip

A solid drive tip enables the operator to advance the outer casing to the bottom of a pre-cored hole or through undisturbed soil to reach the top of the sampling interval. The outer casing is assembled first, followed by the 1.25-in. light-weight center rod system with a solid drive tip. Step by step instructions are listed below.

1. When using a DT325 Standard (28508) or Optional (26720) Cutting Shoe, install an O-ring (9960) at the base of the theads as shown in Figure 4.3. If using an expendable cutting shoe, install an O-ring (9960) on the DT325 Expendable Cutting Shoe Holder (28339) and one o-ring (6834) on the DT325 Expendable Cutting Shoe (28341).

2. Thread the DT325 Cutting Shoe or DT325 Expendable Point Holder onto the leading end of a 3.25-inch OD Probe Rod. *Completely tighten the cutting shoe or cutting shoe holder using a pipe wrench.*

3. Install an O-ring (13942) in both grooves of the DT325 Solid Drive Point (27763 or 28509).

4. Thread the solid drive point into the female end of a 1.25-inch light-weight center rod.

5. Lubricate the O-rings on the solid drive point with a small amount of deionized water. Insert the point and probe rod into the outer casing until the point partially extends from the bottom of the cutting shoe.

6. Place a DT325 Centering Drive Cap (12943) on top of the 1.25-inch light-weight center rod and a GH60 Threadless *Drive Cap (9742) onto the 3.25-inch probe rod (outer casing) as shown in Figure 4.5.*

7. Raise the probe unit hammer assembly to its highest position by fully extending the probe cylinder.

8. Position the assembled outer casing section directly under the hammer with the cutting shoe centered between the toes of the probe foot. The assembled outer casing section should now be parallel to the probe derrick. Step back from the unit and visually check sampler alignment. A magnetic level can be placed on the assembly to check level.

9. Apply static weight and hammer percussion to advance the assembled outer casing until the drive head reaches the ground surface.

NOTE: Activate hammer percussion whenever collecting soil. Percussion helps shear the soil at the leading end of the sampler so that it moves into the sample tube for increased recovery.

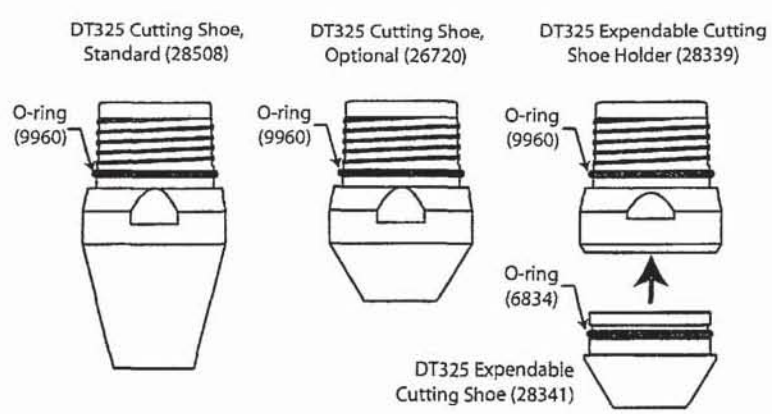

Figure 4.3
DT325 Cutting Shoes Utilize O-ring Seals

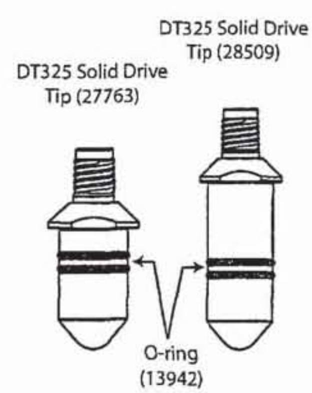

Figure 4.4
Solid Drive Points Utilize Two O-rings

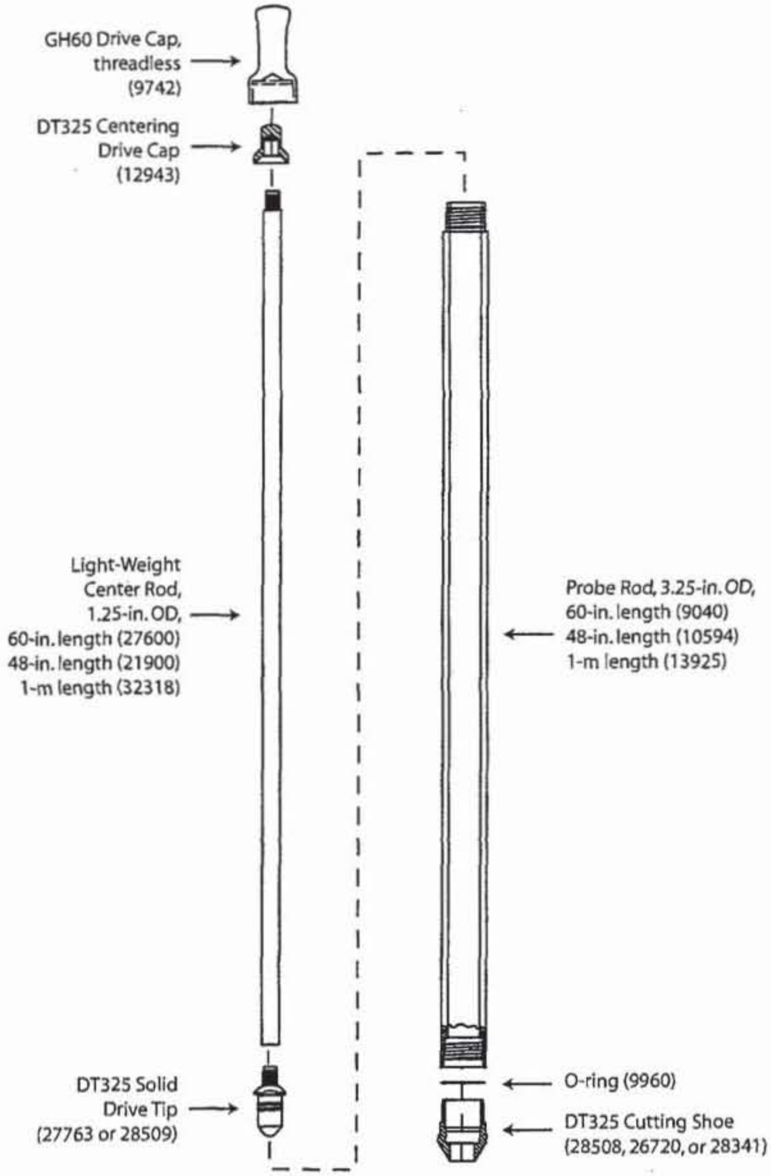

Figure 4.5
Assembly Using the DT325 Solid Drive Tip

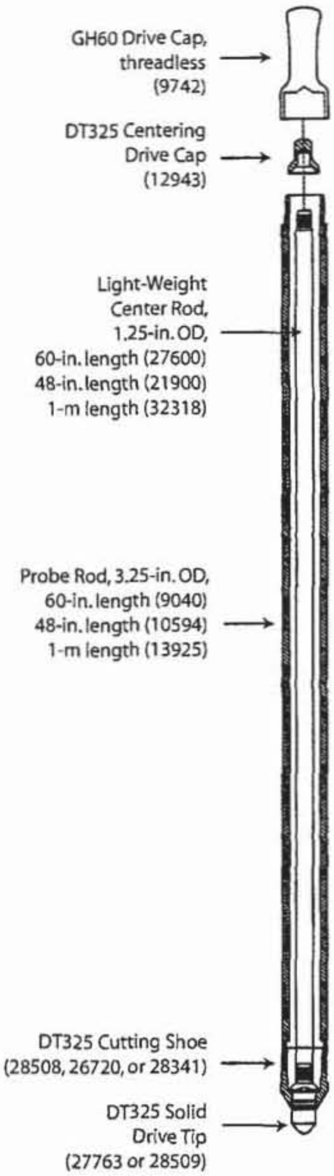

Figure 4.6
Completed Assembly

10. Raise the hammer assembly a few feet and retract the unit to provide access to the top of the outer casing assembly.

11. Remove the centering drive cap and 3.25-inch drive cap.

12. Add additional 1.25-inch light-weight center rods and 3.25-in. probe rods until the sampling interval is reached. At this point, the inner rods can be removed and an assembled sample sheath can be added (See Section 4.4)

4.4 Assembling the Sample Sheath

The sample sheath is used to support the weight of the 1.25-inch light-weight center rods and to protect the liner from damage while advancing the DT325 tool string. The process of assembling the sheath to collect soil samples is given below.

1. Place an O-ring onto the DT325 Liner Retainer. Note: No O-ring is needed for retainer 39011.

2. Slide the retainer ring onto the leading end of the liner. (Fig. 4.7).

3. Place the liner and retainer ring into either end of the sampler sheath (Fig. 4.8).

4. Thread the retainer ring onto the sample sheath. If the tools are clean, it should easily thread on easily by hand (Fig. 4.9).

5. On the opposite end of the sheath, thread on the DT325 Sheath Drive Head. The drive head will connect the sheath to the 1.25-inch light-weight center rods.

Figure 4.7. The retainer ring is placed on the end of the liner.

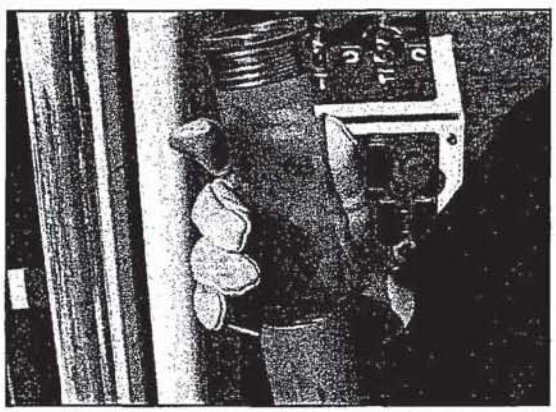

Figure 4.8. The liner and spacer ring are slid into the sample sheath.

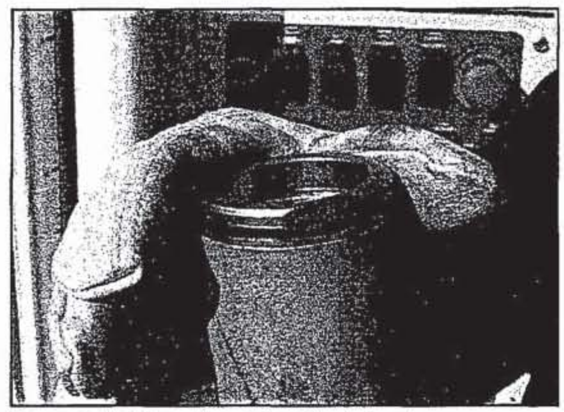

Figure 4.9. Tighten the retainer ring by hand.

The sample sheath is now ready for soil core collection (Section 4.5).

4.5 Soil Core Collection

This section describes collection of continuous soil core samples from within the sealed outer casing of the DT325 Dual Tube Sampling System. The procedure is written for a sampling series that begins at the ground surface. Refer to Figure 4.10 for an illustration of the assembled sampler.

1. When using a DT325 Standard (28508) or Optional (26720) Cutting Shoe, install an O-ring (9960) at the base of the theads as shown in Figure 4.3. If using an expendable cutting shoe, install an O-ring (9960) on the DT325 Expendable Cutting Shoe Holder (28339) and one o-rings (6834) on the DT325 Expendable Cutting Shoe (28341).

2. Thread the DT325 Cutting Shoe or DT325 Expendable Point Holder onto the leading end of a 3.25-inch OD Probe Rod (Fig. 4.11). Completely tighten the cutting shoe or cutting shoe holder using a pipe wrench.

3. Insert the sample sheath assembly into the 3.25-inch OD probe rod.

4. Place a DT325 Buffering Centering Drive Cap (37708) on top of the DT325 Drive Head (Fig. 4.12) and a GH60 Threadless Drive Cap (9742) onto the 3.25-inch probe rod (outer casing, Fig. 4.13).

5. Raise the hydraulic hammer to its highest position by fully extending the probe cylinder.

6. Position the DT325 Sampler directly under the hammer with the cutting shoe centered between the toes of the probe foot (Fig. 4.14). The sampler should now be parallel to the probe derrick. Step back from the unit and visually check sampler alignment. A magnetic level can be placed on the assembly to check level.

7. Apply static weight and hammer percussion to advance the sampler unit until the drive head reaches the ground surface.

   NOTE: Activate hammer percussion whenever collecting soil. Percussion helps shear the soil at the leading end of the sampler so that it moves into the sample tube for increased recovery.

8. Raise the hammer assembly a few feet and retract the unit to provide access to the top of the sampler.

9. Remove the drive cap and thread an additional 1.25-inch light-weight center rod onto the center string. Place the adjustable rod clamp on the top of the 3.25-inch rods to keep the center rods from falling when they are removed (Fig. 4.15).

10. Pull up the 1.25-inch light-weight center rod string along with the sample tube (Fig. 4.16). When available, the 1.25-in. Leaf Puller can be used with overhead winch.

    To sample consecutive soil cores, advance a clean sample sheath and liner down the previously opened hole to the top of the next sampling interval. Add 1.25-inch light-weight center rods as the sample sheath is lowered into the opened hole. An additional 1.25-inch light-weight center rod and 3.25-inch probe rod should be added. Drive the tool string the length of the sampler to collect the next soil core. Proceed to Section 4.6 for instructions on recovering the soil core from the sample sheath.

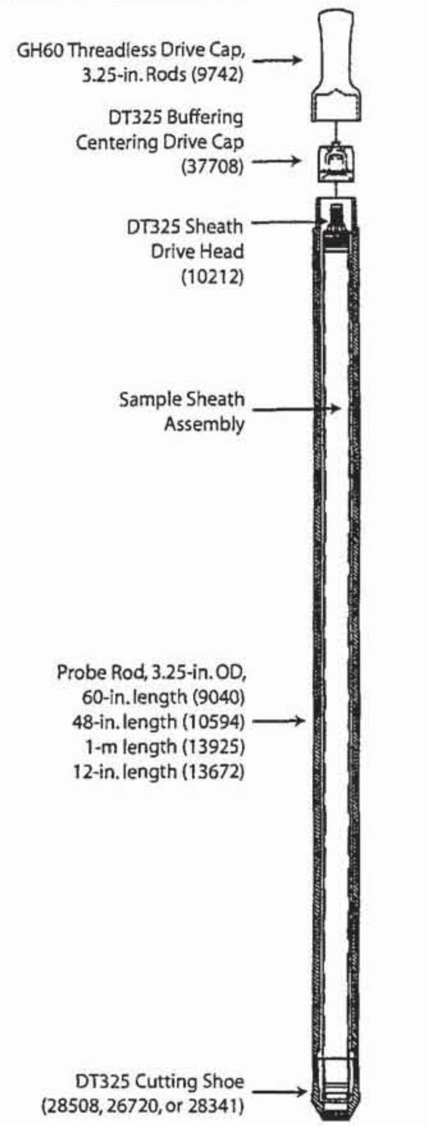

Figure 4.10
Assembled DT325 Sampler

Figure 4.11. The cutting shoe is threaded onto the 3.25-inch probe rod.

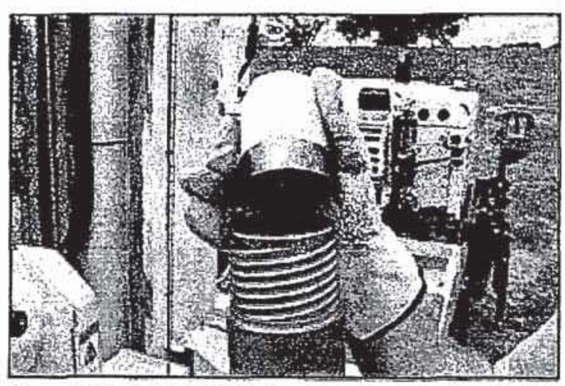

Figure 4.12. A DT325 Buffering Centering Drive Cap (37708) is placed on the DT325 Drive Head.

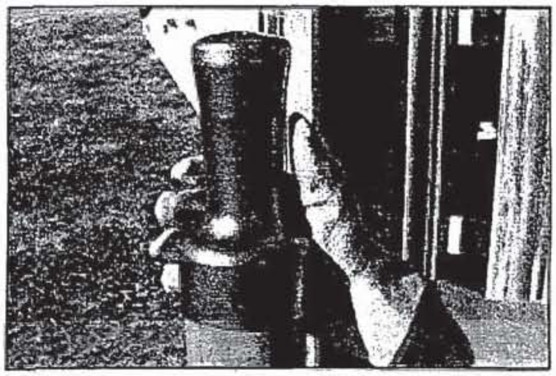

Figure 4.13. Place the threadless drive cap on the 3.25-inch probe rod.

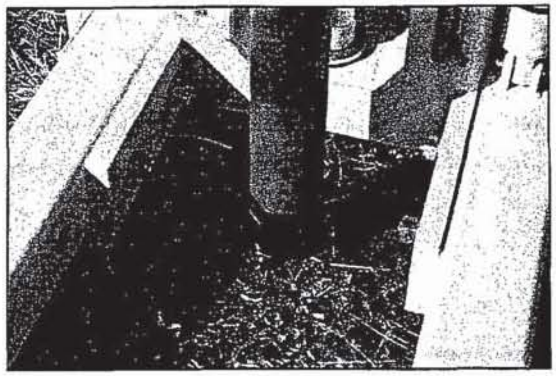

Figure 4.14. The probe rod should be centered between the toes of the probe foot.

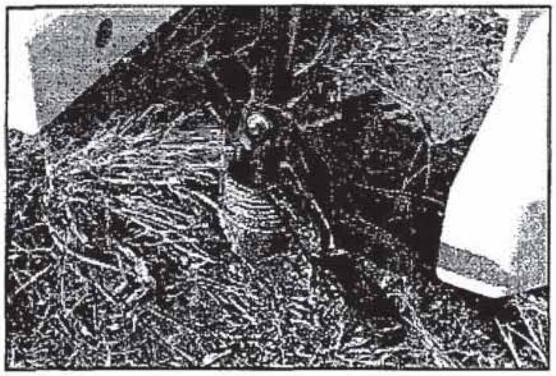

Figure 4.15. The adjustable rod clamp can be used when retrieving the sample.

Figure 4.16. The 1.25-inch light-weight center rods are pulled along with the sample tube.

4.6 Removing Filled Liner from the Sample Sheath

Place the sample tube into the vise. The liner retainer wrench can be used to remove the DT325 Liner Retainer and liner from the sample sheath. If possible, the retainer can be removed by hand (Fig. 4.17). The wrench can be used to gently knock off the retainer if necessary (Fig. 4.17). With the retainer removed, the liner and core can be withdrawn from the sample tube. A Hydraulic Liner Extruder is also available for mounting on your machine to remove liners (Fig. 4.19).

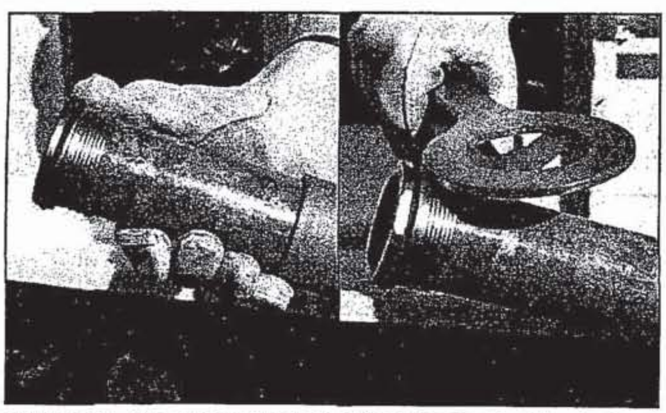

Figure 4.17. The retainer is removed from the sheath, either by hand or with the retainer wrench. Gently tap the retainer with the wrench to remove it from the liner.

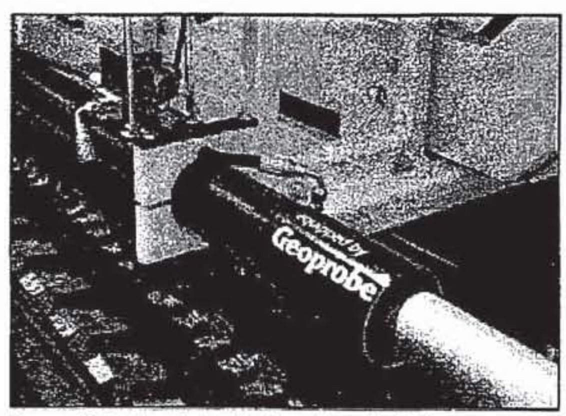

Figure 4.18. The Hydraulic Liner Extruder helps remove the liner.

4.7 Removing a Section of Liner with a DT325 Liner Cutter

The liner and core can be placed on the Universal Liner Holder. Use the DT325 Liner Cutter to safely expose the sample. Begin the cut at the opposite end of the core catcher (Fig. 4.19). It is a little thinner plastic, which makes it easier to begin the cut. Using both hands, smoothly pull the cutter through the liner. The slit liner can be removed and the core is exposed (Fig. 4.20).

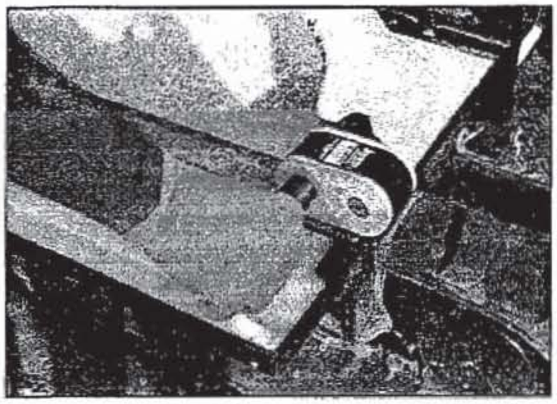

Figure 4.19. The DT325 Liner Cutter is used to safely make a longitudinal cut on the sample.

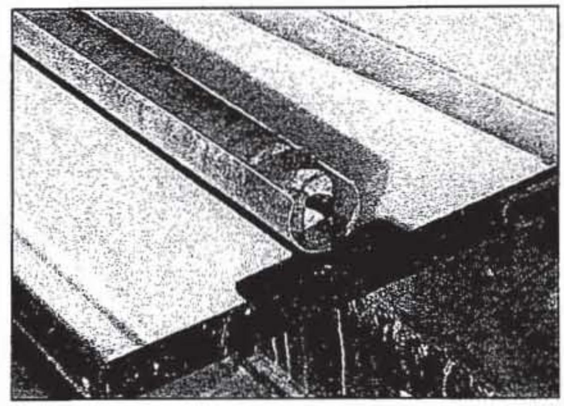

Figure 4.20. The core is exposed by the DT325 Liner Cutter.

4.8 Dual Tube Soil Sampling Tips

Saturated sands are the most difficult formations to sample with the DT325 system. Saturated conditions place positive pressure on the soil outside of the outer casing. When sampling in noncohesive formations (e.g. sands) below the water table, it may be necessary to add water to the outer casing to prevent formation heave. Adding water to the probe rods puts a positive head on the system and may keep formation material from flowing into the rods as the liner and soil sample are retracted. If a small amount of formation material is still drawn into the outer casing as the soil core is retrieved, the material may be displaced by slightly raising the outer casing while lowering the next new liner to depth. Water must be maintained within the outer casing during this process to overcome the hydraulic head imparted by the formation fluid. When retrieving, pull back the sample slowly.

DT325 core catcher liners will help considerably with sample recovery in non-cohesive soils and other materials that do not fill the liner diameter. Core catcher liners are not recommended for cohesive or extruding soils as the core catchers may actually inhibit soil movement into the liner. Also, using a shorter sample interval may improve sample recovery by minimizing wall friction as the material is sampled.

Certain soils have a tendency to exhibit plastic flow or extrusion characteristics. Allowing additional space for these materials will increase the speed of sampling because less time is spent cleaning overfilled sample sheaths. This will also yield a more representative sample. Using a sheath that is a foot or two longer than the sampling interval or using a shorter sample interval (under driving) can create a buffer zone. The DT325 Liner Spacer and Spacer Head were designed for these situations.

Some clay materials will extrude during sampling. Under these conditions, using a shorter sample interval (24-inch liners) may improve sample recovery by minimizing the wall friction as the material is sampled.

It is recommended that an O-ring be used on the liner retainer when sampling in clays. If an O-ring is not used, clay may build up between the sample sheath and the outer casing. It is not necessary to use retainer o-rings in saturated sands and anytime water is present.

It may be helpful to mark the first 1.25-inch light-weight center rod attached to the sheath as an indicator that the sheath is next in line.

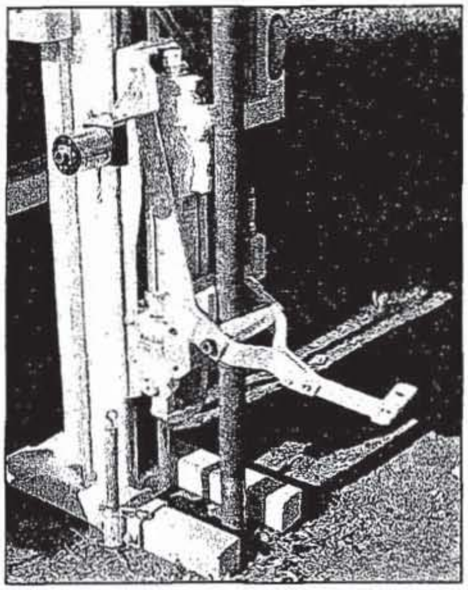

Figure 4.21. Outer casing may be retrieved with a pull cap or rod grip pull system if the probe hole is sealed with granular bentonite.

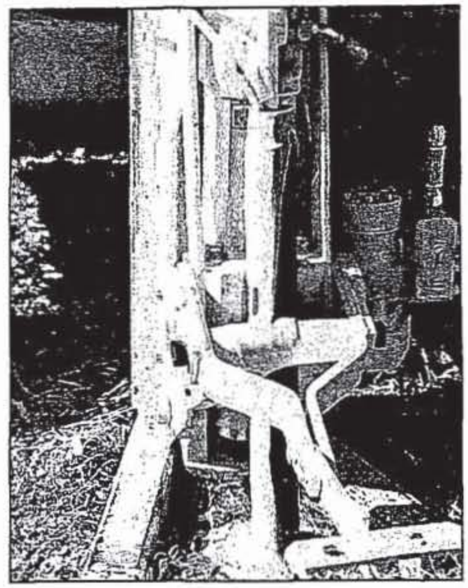

Figure 4.22. A grout machine and flexible tubing allow bottom-up grouting as the outer casing is retrieved.

4.9 Outer Casing Retrieval

The outer casing of the DT325 Dual Tube System may be retrieved in one of three ways:

1. Casing pulled then probe hole sealed from ground surface with granular bentonite.

   The outer casing may be pulled from the ground with the probe machine and a Pull Cap (13257) or a Rod Grip Pull System (for GH40 Hammers [12235] or for GH60 Hammers [44688]) if the probe hole is to be sealed with granular bentonite from the ground surface (Fig. 4.21). This method is used for shallow probe holes in stable formations only. Such conditions allow the entire probe hole to be sealed with granular bentonite.

2. Casing pulled with probe hole sealed from bottom-up during retrieval.

   Bottom-up grouting should be performed during casing retrieval in unstable formations where side slough is probable. Such conditions create void spaces in the probe hole if granular bentonite is installed from the ground surface. (Fig. 4.22)

3. Casing pulled with Geoprobe Prepacked Screen Well installed during retrieval.

   The final option is to install a 2.5-inch OD Geoprobe® Prepacked Screen Monitoring Well in the probe hole during retrieval of the outer casing. A DT325 Expendable Cutting Shoe Holder (28339) and a DT325 Expendable Cutting Shoe (28341) allow the operator to collect continuous soil cores as the outer casing is driven to depth.

   When sampling is complete, the outer rods are raised a few inches, and the expendable cutting shoe is deployed from the holder. This leaves an open casing through which a set of prepacked screens is lowered on the leading end of a PVC riser string. The well is finished, complete with grout barrier, bentonite well seal, and a high-solids bentonite slurry/neat cement grout, during retrieval of the outer casing.

Figure 4.23. Geoprobe® prepacked screens may be installed through the outer casing when an expendable cutting shoe is used.

Refer to Geoprobe® 1.0-in. x 2.5-in. OD and 1.5-in. x 2.5-in. OD Prepacked Screen Monitoring Wells Standard Operating Procedure (Geoprobe® Technical Bulletin No. 992500) for specific information on well installation.

5.0 References

Geoprobe Systems®, 2003. *Tools Catalog, V. 6.*

Geoprobe Systems®, 2005. *Standard Operating Procedure. Geoprobe@ Pneumatic Slug Test Kit. Technical Bulletin No. 19344.*

Geoprobe Systems®, 2010. *Standard Operating Procedure. 1.0-in. x 2.5-in. OD and 1.5-in. x 2.5-in. OD Prepacked Screen Monitoring Wells. Geoprobe® Technical Bulletin No. 992500.*

Geoprobe Systems®

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U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUND WATER SAMPLES FROM MONITORING WELLS

July 30, 1996
Revision 2

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUND WATER SAMPLES FROM MONITORING WELLS

I. SCOPE & APPLICATION

This standard operating procedure (SOP) provides a general framework for collecting ground water samples that are indicative of mobile organic and inorganic loads at ambient flow conditions (both the dissolved fraction and the fraction associated with mobile particulates). The SOP emphasizes the need to minimize stress by low water-level drawdowns, and low pumping rates (usually less than 1 liter/min) in order to collect samples with minimal alterations to water chemistry. This SOP is aimed primarily at sampling monitoring wells that can accept a submersible pump and have a screen, or open interval length of 10 feet or less (this is the most common situation). However, this procedure is flexible and can be used in a variety of well construction and ground-water yield situations. Samples thus obtained are suitable for analyses of ground water contaminants (volatile and semi-volatile organic analytes, pesticides, PCBs, metals and other inorganics), or other naturally occurring analytes.

This procedure does not address the collection of samples from wells containing light or dense non-aqueous phase liquids (LNAPLs and DNAPLs). For this the reader may wish to check: Cohen, R.M. and J.W. Mercer, 1993, DNAPL Site Evaluation; C.K. Smoley (CRC Press), Boca Raton, Florida and U.S. Environmental Protection Agency, 1992, RCRA Ground-Water Monitoring: Draft Technical Guidance; Washington, DC (EPA/530-R-93-001).

The screen, or open interval of the monitoring well should be optimally located (both laterally and vertically) to intercept existing contaminant plume(s) or along flowpaths of potential contaminant releases. It is presumed that the analytes of interest move (or potentially move) primarily through the more permeable zones within the screen, or open interval.

Use of trademark names does not imply endorsement by U.S.EPA but is intended only to assist in identification of a specific type of device.

Proper well construction and development cannot be overemphasized, since the use of installation techniques that are appropriate to the hydrogeologic setting often prevents "problem well" situations from occurring. It is also recommended that as part of development or redevelopment the well should be tested to determine the appropriate pumping rate to obtain stabilization of field indicator parameters with minimal drawdown in shortest amount of time. With this information field crews can then conduct purging and sampling in a more expeditious manner.

The mid-point of the saturated screen length (which should not exceed 10 feet) is used by convention as the location of the pump intake. However, significant chemical or permeability contrast(s) within the screen may require additional field work to determine the optimum vertical location(s) for the intake, and appropriate pumping rate(s) for purging and sampling more localized target zone(s). Primary flow zones (high(er) permealability and/or high(er) chemical concentrations) should be identified in wells with screen lengths longer than 10 feet, or in wells with open boreholes in bedrock. Targeting these zones for water sampling will help insure that the low stress procedure will not underestimate contaminant concentrations. The Sampling and Analysis Plan must provide clear instructions on how the pump intake depth(s) will be selected, and reason(s) for the depth(s) selected.

Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. Achievement of turbidity levels of less than 5 NTU and stable drawdowns of less than 0.3 feet, while desirable, are not mandatory. Sample collection may still take place provided the remaining criteria in this procedure are met. If after 4 hours of purging indicator field parameters have not stabilized, one of 3 optional courses of action may be taken: a) continue purging until stabilization is achieved, b) discontinue purging, do not collect any samples, and record in log book that stabilization could not be achieved (documentation must describe attempts to achieve stabilization) c) discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization (note: there is a risk that the analytical data obtained, especially metals and strongly hydrophobic organic analytes, may not meet the sampling objectives).

Changes to this SOP should be proposed and discussed when the site Sampling and Analysis Plan is submitted for approval. Subsequent requests for modifications of an approved plan must include adequate technical justification for proposed changes. All changes and modifications must be approved before implementation in field.

II. EQUIPMENT

A. Extraction device

Adjustable rate, submersible pumps are preferred (for example, centrifugal or bladder pump constructed of stainless steel or

Teflon).

Adjustable rate, peristaltic pumps (suction) may be used with caution. Note that EPA guidance states: "Suction pumps are not recommended because they may cause degassing, pH modification, and loss of volatile compounds" (EPA/540/P-87/001, 1987, page 8.5-11).

The use of inertial pumps is discouraged. These devices frequently cause greater disturbance during purging and sampling and are less easily controlled than the pumps listed above. This can lead to sampling results that are adversely affected by purging and sampling operations, and a higher degree of data variability.

B. Tubing

Teflon or Teflon lined polyethylene tubing are preferred when sampling is to include VOCs, SVOCs, pesticides, PCBs and inorganics.

PVC, polypropylene or polyethylene tubing may be used when collecting samples for inorganics analyses. However, these materials should be used with caution when sampling for organics. If these materials are used, the equipment blank (which includes the tubing) data must show that these materials do not add contaminants to the sample.

Stainless steel tubing may be used when sampling for VOCs, SVOCs, pesticides, and PCBs. However, it should be used with caution when sampling for metals.

The use of 1/4 inch or 3/8 inch (inner diameter) tubing is preferred. This will help ensure the tubing remains liquid filled when operating at very low pumping rates.

Pharmaceutical grade (Pharmed) tubing should be used for the section around the rotor head of a peristaltic pump, to minimize gaseous diffusion.

C. Water level measuring device(s), capable of measuring to 0.01 foot accuracy (electronic "tape", pressure transducer). Recording pressure transducers, mounted above the pump, are especially helpful in tracking water levels during pumping operations, but their use must include check measurements with a water level "tape" at the start and end of each record.

D. Flow measurement supplies (e.g., graduated cylinder and stop watch).

E. Interface probe, if needed.

F. Power source (generator, nitrogen tank, etc.). If a gasoline generator is used, it must be located downwind and at least 30 feet from the well so that the exhaust fumes do not contaminate the samples.

G. Indicator field parameter monitoring instruments - pH, Eh, dissolved oxygen (DO), turbidity, specific conductance, and temperature. Use of a flow-through-cell is required when measuring all listed parameters, except turbidity. Standards to perform field calibration of instruments. Analytical methods are listed in 40 CFR 136, 40 CFR 141, and SW-846. For Eh measurements, follow manufacturer's instructions.

H. Decontamination supplies (for example, non-phosphate detergent, distilled/deionized water, isopropyl alcohol, etc.).

I. Logbook(s), and other forms (for example, well purging forms).

J. Sample Bottles.

K. Sample preservation supplies (as required by the analytical methods).

L. Sample tags or labels.

M. Well construction data, location map, field data from last sampling event.

N. Well keys.

O. Site specific Sample and Analysis Plan/Quality Assurance Project Plan.

P. PID or FID instrument (if appropriate) to detect VOCs for health and safety purposes, and provide qualitative field evaluations.

III. PRELIMINARY SITE ACTIVITIES

Check well for security damage or evidence of tampering, record pertinent observations.

Lay out sheet of clean polyethylene for monitoring and sampling equipment.

Remove well cap and immediately measure VOCs at the rim of the well with a PID or FID instrument and record the reading in the field logbook.

If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), make one. Describe its location and record the date of the mark in the logbook.

A synoptic water level measurement round should be performed (in the shortest possible time) before any purging and sampling activities begin. It is recommended that water level depth (to 0.01 ft.) and total well depth (to 0.1 ft.) be measured the day before, in order to allow for re-settlement of any particulates in the water column. If measurement of total well depth is not made the day before, it should not be measured until after sampling of the well is complete. All measurements must be taken from the established referenced point. Care should be taken to minimize water column disturbance.

Check newly constructed wells for the presence of LNAPLs or DNAPLs before the initial sampling round. If none are encountered, subsequent check measurements with an interface probe are usually not needed unless analytical data or field head space information signal a worsening situation. Note: procedures for collection of LNAPL and DNAPL samples are not addressed in this SOP.

IV. PURGING AND SAMPLING PROCEDURE

Sampling wells in order of increasing chemical concentrations (known or anticipated) is preferred.

1. Install Pump

Lower pump, safety cable, tubing and electrical lines slowly (to minimize disturbance) into the well to the midpoint of the zone to be sampled. The Sampling and Analysis Plan should specify the sampling depth, or provide criteria for selection of intake depth for each well (see Section I). If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well. Collection of turbid free water samples may be especially difficult if there is two feet or less of standing water in the well.

2. Measure Water Level

Before starting pump, measure water level. If recording pressure transducer is used-initialize starting condition.

3. Purge Well

3a. Initial Low Stress Sampling Event

Start the pump at its lowest speed setting and slowly increase the speed until discharge occurs. Check water level. Adjust pump speed until there is little or no water level drawdown (less than 0.3 feet). If the minimal drawdown that can be achieved exceeds 0.3 feet but remains stable, continue purging until indicator field parameters stabilize.

Monitor and record water level and pumping rate every three to five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump (for example, 0.1 - 0.4 l/min) to ensure stabilization of indicator parameters. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" as pump flow adjustments are made. Purge volume calculations should utilize stabilized drawdown value, not the initial drawdown. Do not allow the water level to fall to the intake level (if the static water level is above the well screen, avoid lowering the water level into the screen). The final purge volume must be greater than the stabilized drawdown volume plus the extraction tubing volume.

Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (bladder, peristaltic), and/or the use of dedicated equipment. If the recharge rate of the well is lower than extraction rate capabilities of currently manufactured pumps and the well is essentially dewatered during purging, then the well should be sampled as soon as the water level has recovered sufficiently to collect the appropriate volume needed for all anticipated samples (ideally the intake should not be moved during this recovery period). Samples may then be collected even though the indicator field parameters have not stabilized.

3b. Subsequent Low Stress Sampling Events

After synoptic water level measurement round, check intake depth and drawdown information from previous sampling event(s) for each well. Duplicate, to the extent practicable, the intake depth and extraction rate (use final pump dial setting information) from previous event(s). Perform purging operations as above.

4. Monitor Indicator Field Parameters

During well purging, monitor indicator field parameters (turbidity, temperature, specific conductance, pH, Eh, DO) every three to five minutes (or less frequently, if appropriate). Note: during the early phase of purging emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments. Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings, taken at three (3) to five (5) minute intervals, are within the following limits:

turbidity (10% for values greater than 1 NTU),
DO (10%),
specific conductance (3%),
temperature (3%),
pH (± 0.1 unit),
ORP/Eh (± 10 millivolts).

All measurements, except turbidity, must be obtained using a flow-through-cell. Transparent flow-through-cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values measured within the cell and may also cause an underestimation of turbidity values measured after the cell. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and continue monitoring activities.

The flow-through-cell must be designed in a way that prevents air bubble entrapment in the cell. When the pump is turned off or cycling on/off (when using a bladder pump), water in the cell must not drain out. Monitoring probes must be submerged in water at all times. If two flow-through-cells are used in series, the one containing the dissolved oxygen probe should come first (this parameter is most susceptible to error if air leaks into the system).

5. Collect Water Samples

Water samples for laboratory analyses must be collected before water has passed through the flow-through-cell (use a by-pass assembly or disconnect cell to obtain sample).

VOC samples should be collected first and directly into pre-preserved sample containers. Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

During purging and sampling, the tubing should remain filled with water so as to minimize possible changes in water chemistry upon contact with the atmosphere. It is recommended that 1/4 inch or 3/8 inch (inside diameter) tubing be used to help insure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, use one of the following procedures to collect samples: (1) add clamp, connector (Teflon or stainless steel) or valve to constrict sampling end of tubing; (2) insert small diameter Teflon tubing into water filled portion of pump tubing allowing the end to protrude beyond the end of the pump tubing, collect sample from small diameter tubing; (3) collect non-VOC samples first, then increase flow rate slightly until the water completely fills the tubing, collect sample and record new drawdown, flow rate and new indicator field parameter values.

Add preservative, as required by analytical methods, to samples immediately after they are collected if the sample containers are not pre-preserved. Check analytical methods (e.g. EPA SW-846, water supply, etc.) for additional information on preservation. Check pH for all samples requiring pH adjustment to assure proper pH value. For VOC samples, this will require that a test sample be collected during purging to determine the amount of preservative that needs to be added to the sample containers prior to sampling.

If determination of filtered metal concentrations is a sampling objective, collect filtered water samples using the same low flow procedures. The use of an in-line filter is required, and the filter size (0.45 um is commonly used) should be based on the sampling objective. Pre-rinse the filter with approximately 25 - 50 ml of ground water prior to sample collection. Preserve filtered water sample immediately. Note: filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations of total mobile contaminants in ground water for human health risk calculations.

Label each sample as collected. Samples requiring cooling (volatile organics, cyanide, etc.) will be placed into a cooler with ice or refrigerant for delivery to the laboratory. Metal samples after acidification to a pH less than 2 do not need to be cooled.

6. Post Sampling Activities

If recording pressure transducer is used, remeasure water level with tape.

After collection of the samples, the pump tubing may either be dedicated to the well for resampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Before securing the well, measure and record the well depth (to 0.1 ft.), if not measured the day before purging began. Note: measurement of total well depth is optional after the initial low stress sampling event. However, it is recommended if the well has a "silting" problem or if confirmation of well identity is needed.

Secure the well.

V. DECONTAMINATION

Decontaminate sampling equipment prior to use in the first well and following sampling of each subsequent well. Pumps will not be removed between purging and sampling operations. The pump and tubing (including support cable and electrical wires which are in contact with the well) will be decontaminated by one of the procedures listed below.

<u>Procedure 1</u>

The decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump or the pump can be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and isopropyl alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is removed. The pump exterior and electrical wires must be rinsed with the decontaminating solutions, as well. The procedure is as follows:

Flush the equipment/pump with potable water.

Flush with non-phosphate detergent solution. If the solution is recycled, the solution must be changed periodically.

Flush with potable or distilled/deionized water to remove all of the detergent solution. If the water is recycled, the water must be changed periodically.

Flush with isopropyl alcohol (pesticide grade). If equipment blank data from the previous sampling event show that the level of contaminants is insignificant, then this step may be skipped.

Flush with distilled/deionized water. The final water rinse must not be recycled.

Procedure 2

Steam clean the outside of the submersible pump.

Pump hot potable water from the steam cleaner through the inside of the pump. This can be accomplished by placing the pump inside a three or four inch diameter PVC pipe with end cap. Hot water from the steam cleaner jet will be directed inside the PVC pipe and the pump exterior will be cleaned. The hot water from the steam cleaner will then be pumped from the PVC pipe through the pump and collected into another container. Note: additives or solutions should not be added to the steam cleaner.

Pump non-phosphate detergent solution through the inside of the pump. If the solution is recycled, the solution must be changed periodically.

Pump potable water through the inside of the pump to remove all of the detergent solution. If the solution is recycled, the solution must be changed periodically.

Pump distilled/deionized water through the pump. The final water rinse must not be recycled.

VI. FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the ground water samples. All field quality control samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples shall be collected for each batch of samples (a batch may not exceed 20 samples). Trip blanks are required for the VOC samples at a frequency of one set per VOC sample cooler.

Field duplicate.

Matrix spike.

Matrix spike duplicate.

Equipment blank.

Trip blank (VOCs).

Temperature blank (one per sample cooler).

Equipment blank shall include the pump and the pump's tubing. If tubing is dedicated to the well, the equipment blank will only include the pump in subsequent sampling rounds.

Collect samples in order from wells with lowest contaminant concentration to highest concentration. Collect equipment blanks after sampling from contaminated wells and not after background wells.

Field duplicates are collected to determine precision of sampling procedure. For this procedure, collect duplicate for each analyte group in consecutive order (VOC original, VOC duplicate, SVOC original, SVOC duplicate, etc.).

If split samples are to be collected, collect split for each analyte group in consecutive order (VOC original, VOC split, etc.). Split sample should be as identical as possible to original sample.

All monitoring instrumentation shall be operated in accordance with EPA analytical methods and manufacturer's operating instructions. EPA analytical methods are listed in 40 CFR 136, 40 CFR 141, and SW-846 with exception of Eh, for which the manufacturer's instructions are to be followed. Instruments shall be calibrated at the beginning of each day. If a measurement falls outside the calibration range, the instrument should be re-calibrated so that all measurements fall within the calibration range. At the end of each day, check calibration to verify that instruments remained in calibration. Temperature measuring equipment, thermometers and thermistors, need not be calibrated to the above frequency. They should be checked for accuracy prior to field use according to EPA Methods and the manufacturer's instructions.

VII. FIELD LOGBOOK

A field log shall be kept to document all ground water field monitoring activities (see attached example matrix), and record all of the following:

Well identification.

Well depth, and measurement technique.

Static water level depth, date, time and measurement technique.

Presence and thickness of immiscible liquid (NAPL) layers and detection method.

Pumping rate, drawdown, indicator parameters values, and clock time, at the appropriate time intervals; calculated or measured total volume pumped.

Well sampling sequence and time of each sample collection.

Types of sample bottles used and sample identification numbers.

Preservatives used.

Parameters requested for analysis.

Field observations during sampling event.

Name of sample collector(s).

Weather conditions.

QA/QC data for field instruments.

Any problems encountered should be highlighted.

Description of all sampling equipment used, including trade names, model number, diameters, material composition, etc.

VIII. DATA REPORT

Data reports are to include laboratory analytical results, QA/QC information, and whatever field logbook information is needed to allow for a full evaluation of data useability.

EXAMPLE (Minimum Requirements)
Well PURGING-FIELD WATER QUALITY MEASUREMENTS FORM

Page____of____

Location (Site/Facility Name)______________________
Well Number______________ Date______________
Field Personnel______________________
Sampling Organization______________________
Identify MP

Depth to (below MP) ________ top / ________ bottom of screen
Pump Intake at (ft. below MP)______________
Purging Device; (pump type)______________

Clock Time 24 HR	Water Depth below MP ft	Pump Dial[1]	Purge Rate ml/min	Cum. Volume Purged liters	Temp. °C	Spec. Cond.[2] µS/cm	pH	ORP/ Eh[3] mv	DO mg/L	Turb- idity NTU	Comments

1. Pump dial setting (for example: hertz, cycles/min, etc).
2. µSiemens per cm(same as µmhos/cm)at 25 °C.
3. Oxidation reduction potential (stand in for Eh).

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STANDARD OPERATING PROCEDURE (SOP) SD-01

DECONTAMINATION OF SEDIMENT SAMPLING EQUIPMENT

SCOPE AND APPLICATION

This SOP describes procedures for decontaminating sampling and processing equipment contaminated by either inorganic or organic materials. To prevent potential cross contamination of samples, all reusable sediment sampling and processing equipment is decontaminated before each use. At the sample collection site, a decontamination area is established in a clean location that is upwind of actual sampling locations, if possible. All sediment sampling and processing equipment is cleaned in this location. Decontaminated equipment is stored away from areas that may cause recontamination. When handling decontamination chemicals, field personnel must follow all relevant procedures and wear protective clothing as stipulated in the site-specific health and safety plan (HSP).

Sampling equipment (e.g., van Veen, Ekman, Ponar, core tubes) may be used to collect samples that will 1) undergo a full-suite analysis (organics, metals, and conventional parameters) or 2) be analyzed for metals and conventional parameters only. Decontamination of sampling equipment used for both analyte groups should follow the order of a detergent wash, site water rinse, organic solvent rinses, and final site water rinse. Sample processing equipment (e.g., bowls, spoons) has a final rinse with distilled/deionized water rinse instead of site water. If the surface of stainless steel equipment appears to be rusting (possibly due to prolonged contact with organic-rich sediment), it should undergo an acid rinse and a site-water rinse at the end of each sampling day to minimize corrosion.

EQUIPMENT AND REAGENTS REQUIRED

Equipment required for decontamination includes the following:

- Polyethylene or polypropylene tub (to collect solvent rinsate)
- Plastic bucket(s) (e.g., 5-gal bucket)
- Tap water or site water
- Carboy, distilled/deionized water (analyte-free; received from testing laboratory or other reliable source)
- Properly labeled squirt bottles

- Funnels
- Alconox®, Liquinox®, or equivalent industrial detergent
- Pesticide-grade acetone and hexane (consult the project-specific field sampling plan [FSP], as the solvents may vary by EPA region or state)
- 10 percent (v/v) nitric acid (reagent grade) for inorganic contaminants
- Baking soda
- Long-handled, hard-bristle brushes
- Extension arm for cleaning core liners
- Plastic sheeting, garbage bags, and aluminum foil
- Core liner caps or plastic wrap and rubber bands
- Personal protective equipment as specified in the health and safety plan.

PROCEDURES

Decontamination Procedures for Full Suite Analysis (Organic, Metal, or Conventional Parameters)

Two organic solvents are used in this procedure. The first is miscible with water (e.g., ethanol) and is intended to scavenge water from the surface of the sampling equipment and allow the equipment to dry quickly. This allows the second solvent to fully contact the surface of the sampler. Make sure that the solvent ordered is anhydrous or has a very low water content (i.e., < 1 percent). If ethanol is used, make sure that the denaturing agent in the alcohol is not an analyte in the samples. The second organic solvent is hydrophobic (e.g., hexane) and is intended to dissolve any organic chemicals that are on the surface of the equipment.

The exact solvents used for a given project may vary by EPA region or state (see project-specific FSP). Integral uses ethanol and hexane as preferred solvents for equipment decontamination. If specified in the project-specific FSP, isopropanol or acetone can be substituted for ethanol, and methanol can be substituted for hexane in the decontamination sequence. The choice of solvents is also dependent on the kind of material from which the equipment is made (e.g., acetone cannot be used on polycarbonate), and the ambient temperature (e.g., hexane is too volatile in hot climates). In addition, although methanol is sometimes slightly more effective than other solvents, its use is discouraged due to potential toxicity to sampling personnel.

The specific procedures for decontaminating sediment sampling equipment and sediment compositing equipment are as follows:

1. Rinse the equipment thoroughly with tap or site water to remove visible sediment. Perform this step onsite for all equipment, including core liners that will not be used again until the next day of sampling. After removing visible solids, set aside sampling equipment that does not need to be used again that day; this equipment should be thoroughly cleaned in the field laboratory at the end of the day.

2. Pour a small amount of concentrated laboratory detergent into a bucket (i.e., about 1–2 tablespoons per 5-gal bucket) and fill it halfway with tap or site water. If the detergent is in crystal form, make sure all crystals are completely dissolved prior to use.

3. Scrub the equipment in the detergent solution using a long-handled brush with rigid bristles. For the polycarbonate core liners, use a round brush attached to an extension arm to reach the entire inside of the liners, scrubbing with a back-and-forth motion. Be sure to clean the outside of core liners, bowls, and other pieces that may be covered with sediment.

4. Double rinse the equipment with tap or site water and set right-side-up on a stable surface to drain. The more completely the equipment drains, the less solvent will be needed in the next step. Do not allow any surface that will come in contact with the sample to touch any contaminated surface.

5. If the surface of stainless steel equipment appears to be rusting (this will occur during prolonged use in anoxic marine sediments), passivate[1] the surface as follows (if no rust is present, skip to next step). Rinse with a 10 percent (v/v) nitric acid solution using a squirt bottle, or wipe all surfaces using a saturated paper towel. Areas showing rust may require some rubbing with the paper towel. If using a squirt bottle, let the excess acid drain into the waste container (which may need to be equipped with a funnel). Double-rinse equipment with tap or site water and set right-side-up on a stable surface to drain thoroughly.

6. Carefully rinse the equipment with ethanol from a squirt bottle, and let the excess solvent drain into a waste container (which may need to be equipped with a funnel). Hold core liners over the waste container and turn them slowly so the stream of solvent contacts the entire surface. Turn the sample apparatus (e.g., grab sampler) on its side and open it to wash it most effectively. Set the equipment in a clean location and allow it to air dry. Use only enough solvent to scavenge all of the water and flow off the surface of the equipment (i.e., establish sheet flow) into the waste container. Allow equipment to drain as much as possible. Ideally, the equipment will be dry. The more thoroughly it drains, the less solvent will be needed in the next step.

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[1] Passivation is the process of making a material less reactive relative to another material. For example, before sediment is placed in a stainless-steel container, the container can be passivated by rinsing it with a dilute solution of nitric acid and deionized water.

7. Carefully rinse the drained or air-dried equipment with hexane from a squirt bottle, and let the excess solvent drain into the waste container (which may need to be equipped with a funnel). If necessary, widen the opening of the squirt bottle to allow enough solvent to run through the core liners without evaporating. (Hexane acts as the primary solvent of organic chemicals. Ethanol is soluble in hexane but water is not. If water beading occurs, it means that the equipment was not thoroughly rinsed with acetone or that the acetone that was purchased was not free of water.) When the equipment has been rinsed with hexane, set it in a clean location and allow the hexane to evaporate before using the equipment for sampling. Use only enough solvent to scavenge all of the acetone and flow off the surface of the equipment (i.e., establish sheet flow) into the waste container.

8. Do a final rinse with site water for the sampling equipment (i.e., van Veen, Ekman, Ponar, core tubes) and with distilled/deionized water for processing equipment (i.e., stainless-steel bowls and spoons). Equipment does not need to be dried before use.

9. If the decontaminated sampling equipment is not to be used immediately, wrap small stainless-steel items in aluminum foil (dull side facing the cleaned area). Seal the polycarbonate core liners at both ends with either core caps or cellophane plastic and rubber bands. Close the jaws of the Ekman and Ponar grab samplers and wrap in aluminum foil.

   If the sample collection or processing equipment is cleaned at the field laboratory and transported to the site, then the decontaminated equipment will be wrapped in aluminum foil (dull side facing the cleaned area) and stored and transported in a clean plastic bag (e.g., a trash bag) until ready for use, unless the project-specific FSP lists special handling procedures.

10. Rinse or wipe with a wetted paper towel all stainless-steel equipment at the end of each sampling day with 10 percent (v/v) normal nitric acid solution. Follow with a freshwater rinse (site water is okay as long as it is not brackish or salt water).

11. After decontaminating all of the sampling equipment, place the disposable gloves and used foil in garbage bags for disposal in a solid waste landfill. When not in use, keep the waste solvent container closed and store in a secure area. The waste should be transferred to empty solvent bottles and disposed of at a licensed facility per the procedures listed in the project-specific FSP. When not in use, keep the waste acid container closed and store in a secure area. The acid waste should be neutralized with baking soda and disposed of per the procedures listed in the project-specific FSP.

Decontamination Procedures for Metals and Conventional Parameters Only

The specific procedures for decontaminating sediment sampling equipment and sediment processing equipment are as follows:

1. Rinse the equipment thoroughly with tap or site water to remove the visible sediment. Perform this step onsite for all equipment, including core liners that will not be used again until the next day of sampling. Set aside pieces that do not need to be used again that day; these pieces should be and thoroughly cleaned in the field laboratory at the end of the day.
2. Pour a small amount of concentrated laboratory detergent into a bucket (i.e., about 1–2 tablespoons per 5-gal bucket) and fill it halfway with tap or site water. If the detergent is in crystal form, make sure all crystals are completely dissolved prior to use.
3. Scrub the equipment in the detergent solution using a long-handled brush with rigid bristles. For the polycarbonate core liners, use a round brush attached to an extension arm to reach the entire inside of the liners, scrubbing with a back-and-forth motion. Be sure to clean the outside of core liners, bowls, and other pieces that may be covered with sediment.
4. Double-rinse the equipment with tap or site water and set right-side-up on a stable surface to drain. Do not allow any surface that will come in contact with the sample to touch any contaminated surface.
5. If the surface of stainless steel equipment appears to be rusting (this will occur during prolonged use in anoxic marine sediments), passivate[2] the surface as follows (if no rust is present, skip to next step). Rinse with a 10 percent (v/v) nitric acid solution using a squirt bottle, or wipe all surfaces using a saturated paper towel. Areas showing rust may require some rubbing with the paper towel. If using a squirt bottle, let the excess acid drain into the waste container (which may need to be equipped with a funnel). Double-rinse sampling equipment with tap or site water and set right-side-up on a stable surface to drain. Double-rinse processing equipment with distilled/deionized water and allow to drain.
6. If the decontaminated sampling equipment is not to be used immediately, wrap small stainless-steel items in aluminum foil (dull side facing the cleaned area). Seal the polycarbonate core liners at both ends with either core caps or cellophane plastic and rubber bands. Close the jaws of the Ekman and Ponar grab samplers and wrap in aluminum foil.

   If the sample collecting or processing equipment is cleaned at the field laboratory and transported to the site, then the decontaminated equipment will be wrapped in aluminum foil (dull side facing the cleaned area) and stored and transported in a clean plastic bag until ready for use, unless the project-specific FSP lists special handling procedures.

[2] Passivation is the process of making a material less reactive relative to another material. For example, before sediment is placed in a stainless-steel container, the container can be passivated by rinsing it with a dilute solution of nitric acid and deionized water.

7. After decontaminating all of the sampling equipment, place the disposable gloves and used foil in garbage bags for disposal in a solid waste landfill. When not in use, keep the waste acid container closed and store in a secure area. The acid waste should be neutralized with baking soda and disposed of per the procedures listed in the project-specific FSP.

STANDARD OPERATING PROCEDURE (SOP) AP-03

SAMPLE CUSTODY

SCOPE AND APPLICATION

This SOP describes Integral procedures for custody management of environmental samples.

A stringent, established program of sample chain-of-custody will be followed during sample storage and shipping activities to account for each sample. The procedure outlined herein will be used with SOP AP-01, which covers sample packaging and shipping; SOP AP-02, which covers the use of field logbooks and other types of field documentation; and SOP AP-04, which covers sample labeling. Chain-of-custody (COC) forms ensure that samples are traceable from the time of collection through processing and analysis until final disposition. A sample is considered to be in a person's custody if any of the following criteria are met:

1. The sample is in the person's possession
2. The sample is in the person's view after being in his or her possession
3. The sample is in the person's possession and is being transferred to a designated secure area
4. The sample has been locked up to prevent tampering after it was in the person's possession.

At no time is it acceptable for samples to be outside of Integral personnel's custody unless the samples have been transferred to a secure area (i.e., locked up). If the samples cannot be placed in a secure area, then an Integral field team member must physically remain with the samples (e.g., at lunch time one team member must remain with the samples).

CHAIN-OF-CUSTODY FORMS

The COC form is critical because it documents sample possession from the time of collection through final disposition. The form also provides information to the laboratory regarding what analyses are to be performed on the samples that are shipped.

Complete the COC form after each field collection activity and before shipping the samples to the laboratory. Sampling personnel are responsible for the care and custody of the samples until they are shipped. The individuals relinquishing and receiving the samples must sign the

COC form(s), indicating the time and date of the transfer, when transferring possession of the samples.

A COC form consists of three-part carbonless paper with white, yellow, and pink copies. The sampling team leader keeps the pink copy. The white and yellow sheets are placed in a sealed plastic bag and secured inside the top of each transfer container (e.g., cooler). Field staff retain the pink sheet for filing at the Integral project manager's location. Each COC form has a unique four-digit number. This number and the samples on the form must be recorded in the field logbook. Integral also uses computer-generated COC forms. If computer-generated forms are used, then the forms must be printed in triplicate and all three sheets signed so that two sheets can accompany the shipment to the laboratory and one sheet can be retained on file. Alternatively, if sufficient time is available, the computer-generated forms will be printed on three-part carbonless paper.

Record on the COC form the project-assigned sample number and the unique tag number at the bottom of each sample label. The COC form also identifies the sample collection date and time, type of sample, project name, and sampling personnel. In addition, the COC form provides information on the preservative or other sample pretreatment applied in the field and the analyses to be conducted by referencing a list of specific analyses or the statement of work for the laboratory. The COC form is sent to the laboratory along with the sample(s).

PROCEDURES

Use the following guidelines to ensure the integrity of the samples:

1. Sign and date each COC form. Have the person who relinquishes custody of the samples also sign this form.
2. At the end of each sampling day and prior to shipping or storage, make COC entries for all samples. Check the information on the labels and tags against field logbook entries.
3. Do not sign the COC form until the team leader has checked the information for inaccuracies. Make corrections by drawing a single line through any incorrect entry, and then initial and date it. Make revised entries in the space below the entries. After making corrections, mark out any blank lines remaining on the COC form, using single lines that are initialed and dated. This procedure will prevent any unauthorized additions.

   At the bottom of each COC form is a space for the signatures of the persons relinquishing and receiving the samples and the time and date of the transfer. The time the samples were relinquished should match exactly the time they were received by another party. Under no circumstances should there be any time when custody of the samples is undocumented.

4. If samples are sent by a commercial carrier not affiliated with the laboratory, such as FedEx or United Parcel Service (UPS), record the name of the carrier on the COC form. Also enter on the COC form any tracking numbers supplied by the carrier. The time of transfer should be as close to the actual drop-off time as possible. After signing the COC forms and removing the pink copy, seal them inside the transfer container.
5. If errors are found after the shipment has left the custody of sampling personnel, make a corrected version of the forms and send it to all relevant parties. Fix minor errors by making the change on a copy of the original with a brief explanation and signature. Errors in the signature block may require a letter of explanation.
6. Provide a COC form and an Archive Record form for any samples that are archived internally at Integral.

Upon completion of the field sampling event, the sampling team leader is responsible for submitting all COC forms to be copied. A discussion of copy distribution is provided in SOP AP-02.

CUSTODY SEAL

As security against unauthorized handling of the samples during shipping, affix two custody seals to each sample cooler. Place the custody seals across the opening of the cooler (front right and back left) prior to shipping. Be sure the seals are properly affixed to the cooler so they cannot be removed during shipping. Additional tape across the seal may be prudent.

SHIPPING AIR BILLS

When samples are shipped from the field to the testing laboratory via a commercial carrier (e.g., FedEx, UPS), the shipper provides an air bill or receipt. Upon completion of the field sampling event, the sampling team leader will be responsible for submitting the sender's copy of all shipping air bills to be copied at an Integral office. A discussion of copy distribution is provided in SOP AP-02. Note the air bill number (or tracking number) on the applicable COC forms or, alternatively, note the applicable COC form number on the air bill to enable the tracking of samples if a cooler becomes lost.

ACKNOWLEDGMENT OF SAMPLE RECEIPT FORMS

In most cases, when samples are sent to a testing laboratory, an Acknowledgment of Sample Receipt form is faxed to the project QA/QC coordinator the day the samples are received by the laboratory. The person receiving this form is responsible for reviewing it, making sure that the laboratory has received all the samples that were sent, and verifying that the correct analyses were requested. If an error is found, call the laboratory immediately, and document any decisions made during the telephone conversation, in writing, on the Acknowledgment of Sample Receipt form. In addition, correct the COC form and fax the corrected version to the laboratory.

Submit the Acknowledgment of Sample Receipt form (and any modified COC forms) to be copied. A discussion of copy distribution is provided in SOP AP-02.

ARCHIVE RECORD FORMS

On the rare occasion that samples are archived at an Integral office, it is the responsibility of the project manager to complete an Archive Record form. This form is to be accompanied by a copy of the COC form for the samples, and will be placed in a locked file cabinet. The original COC form remains with the samples in a sealed Ziploc® bag.

ATTACHMENT A-2
FIELD FORMS

ANCHOR QEA

LOG OF EXPLORATORY BORING

CLIENT/PROJECT NAME____________________ BORING #________

PROJECT NUMBER____________________ DATE BEGAN________

GEOLOGIST/ENGINEER____________________ DATE COMPLETED________

DRILLING CONTRACTOR____________________ TOTAL DEPTH________

DRILLING METHOD____________________ SHEET_____ OF_____

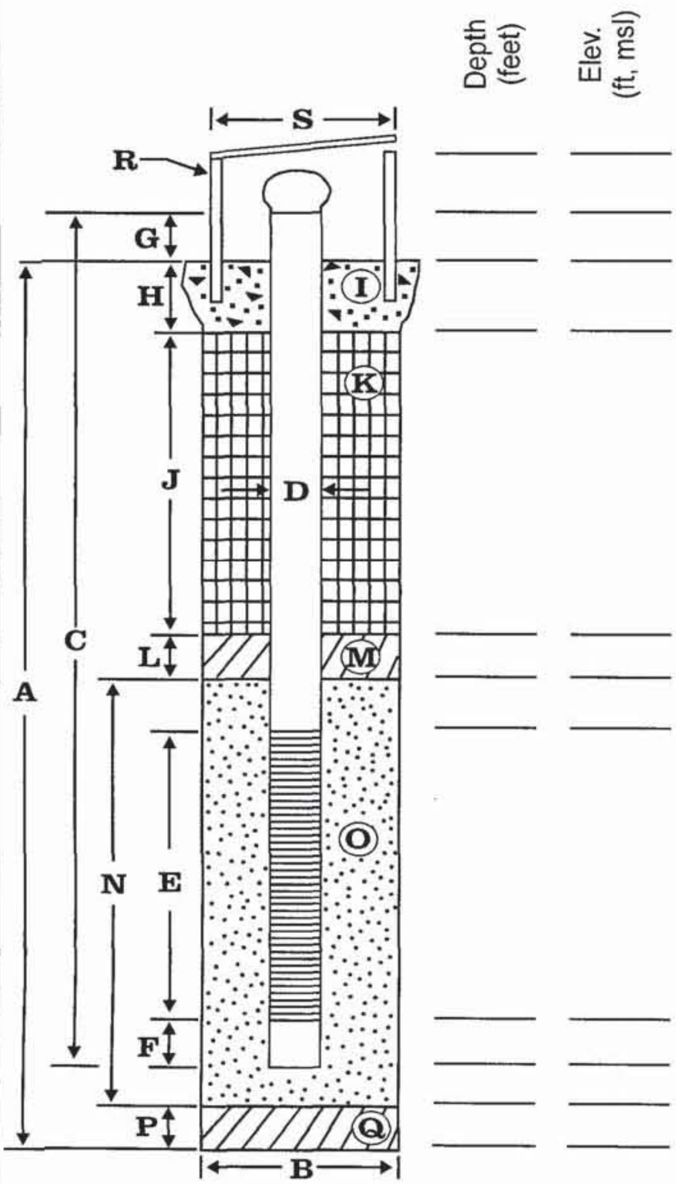
HOLE DIAMETER____________________

OTHER*	WELL OR PIEZOMETER DETAILS	SAMPLING DATA						DEPTH IN FEET	SOIL GROUP SYMBOL (USCS)	Field location of boring
		SAMPLING METHOD	SAMPLE NUMBER	FID / PID (ppm)	RECOVERY (feet)	BLOWS / 6 INCHES	DEPTH SAMPLED			**LITHOLOGIC DESCRIPTION**
								1		
								2		
								3		
								4		
								5		
								6		
								7		
								8		
								9		
								0		
								1		
								2		
								3		
								4		
								5		
								6		
								7		
								8		
								9		
								0		

Remarks:

WELL DETAILS

Project Number:	______	Boring/Well No.:	______
Client Name:	______	Top of Casing Elev.:	______
Project Name:	______	Ground Surface Elev.:	______
Location:	______	Installation Date:	______
Driller:	______	Permit/Start Card No.:	______



EXPLORATORY BORING

A. Total depth: ______ **ft.**
B. Diameter ______ **in.**
Drilling method: ______

WELL CONSTRUCTION

C. Well casing length: ______ **ft.**
Well casing material: ______
D. Well casing diameter: ______ **in.**
E. Well screen length: ______ **ft.**
Well screen type: ______
Well screen slot size: ______ **in.**
F. Well sump/end cap length: ______ **ft.**
G. Well casing height (stickup): ______ **ft.**
H. Surface seal thickness: ______ **ft.**
I. Surface seal material: ______
J. Annular seal thickness: ______ **ft.**
K. Annular seal material: ______
L. Filter pack seal thickness: ______ **ft.**
M. Filter pack seal material: ______
N. Sand pack thickness: ______ **ft.**
O. Sand pack material: ______
P. Bottom material thickness: ______ **ft.**
Q. Bottom material: ______
R. Protective casing material: ______
Well centralizer depths: ______ **ft.**
S. Protective casing diameter: ______ **in.**

NOTES:

Installed by: ______

Reviewed by: ______

Date: ______

ELL DEVELOPMENT FORM

ANCHOR QEA

oject No.	Date: Well:
e Location:	Initial DTB: Final DTB:
ime:	Initial DTW: Final DTW:
evelopment Method:	Casing Volume:
tal Water Removed:	Casing Diameter:
ater Contained ?	Meter #:
timate of specific capacity or recharge to well:	

ime	Cum. Vol. Removed	Turbidity	Dissolved Oxygen	Specific Conductance	Temperature	pH	ORP	DTW (TOC)	Appearance/Comments

WATER LEVEL DATA SHEET

ANCHOR QEA

PROJECT NAME:

SITE ADDRESS:

WIND FROM:	N	NE	E	SE	S	SW	W	NW	LIGHT	MEDIUM	HEAVY
WEATHER:	SUNNY		CLOUDY		RAIN			?	**TEMPERATURE:**	°F . °C

[Circle appropriate units]

HYDROLOGY/LEVEL MEASUREMENTS (Nearest 0.01 ft)

Well ID	Date	Time (Equil.)	Time (Meas.)	DT-Bottom	DT-Product	DT-Water	DTP-DTW [Product Thickness]	DTB-DTW [Water Column] [Water Column x Gal/ft]
	/ /	:	:	.	.	.	.	.
	/ /	:	:	.	.	.	.	.
	/ /	:	:	.	.	.	.	.
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	/ /	:	:	.	.	.	.	.

SAMPLER:

(PRINTED NAME) (SIGNATURE)

Address:

Chain of Custody Record

Client Information	Sampler:	Lab PM:	Carrier Tracking No(s):	COC No:
Client Contact:	Phone:	E-Mail:		Page: Page 1
Company: Anchor QEA LLC				Job #:

		Analysis Requested
Address: 1423 3rd Avenue, Ste 300	**Due Date Requested:**	
City: Seattle	**TAT Requested (days):**	
State, Zip: WA, 98101		
Phone: 206-287-9130(Tel)	PO #:	
Email: dpeterson@anchorqea.com	WO #:	
Project Name:	Project #:	
Site:	SSOW#:	

Preservation Codes:

A - HCL
B - NaOH
C - Zn Acetate
D - Nitric Acid
E - NaHSO4
F - MeOH
G - Amchlor
H - Ascorbic Acid
I - Ice
J - DI Water
K - EDTA
L - EDA
M - Hexane
N - None
O - AsNaO2
P - Na2O4S
Q - Na2SO3
R - Na2S2SO3
S - H2SO4
T - TSP Dodecahydrate
U - Acetone
V - MCAA
W - ph 4-5
Z - other (specify)

Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)														Total Number of containers	Special Instructions/Note:
			Preservation Code:																		
			G		N																
			G		N																
			G		N																
			G		N																
			G		N																
			G		N																
			G		N																
			G		N																
			G		N																
			G		N																
			G		N																

Possible Hazard Identification

☐ *Non-Hazard* ☐ *Flammable* ☐ *Skin Irritant* ☐ *Poison B* ☐ *Unknown* ☐ *Radiological*

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)

☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For _________ Months*

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: | Custody Seal No.:

Cooler Temperature(s) °C and Other Remarks:

APPENDIX B
BENCHMARK SURVEY DATA

HARRIS COUNTY FLOODPLAIN REFERENCE MARKS

Project Name:	**Tropical Storm Allison Recovery Project**	Floodplain RM No.: **070085** Stream Number: G 103-00-00	**STATUS Recovered**
County: Harris Key Map No.: 499B	State: Texas	Established By: Date Established:	Baseline Corporation 1/13/2003
NGS Clasification(1):	Range VI	Watershed:	San Jacinto
RM's Directly Tied: Units of Measure:	070080, 070075, 070090 US Survey Foot	Survey Method Horz: Survey Method Vert:	GPSOBS GPSOBS
Horizontal Datum: Horizontal Adj.(2): Projection Zone:	NAD83 Texas South Central 4204	Vertical Datum: Vertical Adj.(3): Geoid Model Used:	NAVD88 2001 Adjustment GEOID99 (Conus)
Station Name:	070085	Contractor PID:	0
Marker:	BRASS DISC	Rod Depth:	.000000
Stamping:	RM 070085	Sleeve Depth:	.000000
Mark Logo:	Floodplain R	Geoid Height:	-89.16
Latitude:	29° 47' 31.43271"	Northing:	13856382.64
Longitude:	95° 04' 45.85540"	Easting:	3211801.42
Ellipsoid Height:	-84.75	Elevation(4):	4.66
Convergence:	1° 55' 15"	Scale Factor:	.999894
Satellite Observable:	YES	Elevation Factor:	1.000004
NGS PID (if applic):	NA	Combined Factor:	.999899

General Location

Monmouth @ I-10

To Reach Description

I-10 east and Monmouth Monument is on a inlet at the northeast corner of Monmouth and eastbound I-10 feeder road.

Notes:

1. This is NGS' new classification system. Range VI indicates that this position meets the 0.02m-0.05m Accuracy Standard for Horizontal Position, Ellipsoidal Height, and Orthometric Height (elevation) at the 95% confidence level (m=meters).
2. Horizontal Adjustment - This survey is constrained to the NGS Published Horizontal positions of the geodetic stations adjusted by NGS in 2001.
3. Vertical Adjustment - This survey is constrained to the NGS Published Elevation for Northeast 2250 CORS ARP adjusted by NGS in 2001 and as published in PID AJ6430. Epoch Date 1997.00.
4. The elevation shown equals the Ellipsoid Height minus Geoid Height (from GEOID99) plus a constant of 0.253 feet.

Station Recovery Data:

RECOVERY DATA FORM - submit to Harris County Permits Division

For more information on Project Standards go to TECHNICAL DATA REPORTS

HARRIS COUNTY FLOODPLAIN REFERENCE MARKS

Project Name:	Tropical Storm Allison Recovery Project	Floodplain RM No.:	070085
		Stream Number:	G 103-00-00

Station Sketch:

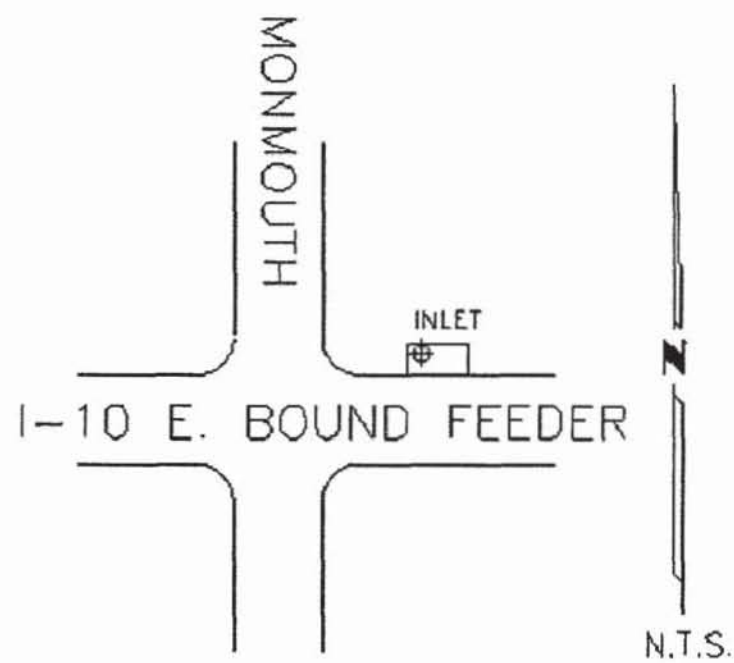
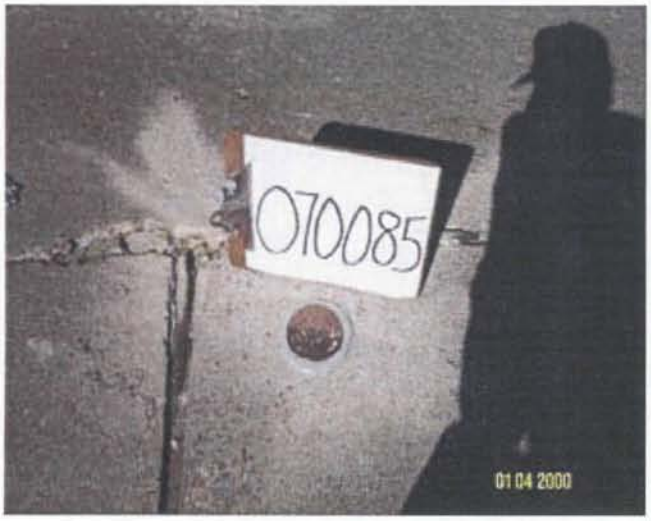


Photo 1-Station Detail:	Photo 2-Station Area Picture:



Point Information Disclaimer: This data has been supplied by Harris County Flood Control District. No express or implied warranties are made by Harris County for the accuracy, completeness, reliability, usability, or suitability of the point data. Harris County assumes no responsibility for incorrect results or damages resulting from the use of the data.

HARRIS COUNTY FLOODPLAIN REFERENCE MARKS

Project Name:	**Tropical Storm Allison Recovery Project**	**Floodplain RM No.:** 070525 **Stream Number:** G103-01-00	**STATUS** Recovered
County: Harris **State:** Texas **Key Map No.:** 498H		**Established By:** NGS **Date Established:**	
NGS Clasification(1):	Range VI	**Watershed:**	San Jacinto
RM's Directly Tied: **Units of Measure:**	070495, 070075, 070080 US Survey Foot	**Survey Method Horz:** **Survey Method Vert:**	GPSOBS GPSOBS
Horizontal Datum: **Horizontal Adj.(2):** **Projection Zone:**	NAD83 Texas South Central 4204	**Vertical Datum:** **Vertical Adj.(3):** **Geoid Model Used:**	NAVD88 2001 Adjustment GEOID99 (Conus)
Station Name:	070525	**Contractor PID:**	.000000
Marker:	METAL ROD	**Rod Depth:**	.000000
Stamping:	HGCSD 31 1986	**Sleeve Depth:**	.000000
Mark Logo:	NGS	**Geoid Height:**	-89.00
Latitude:	29ø 46' 56.86689"	**Northing:**	13852649.28
Longitude:	95ø 06' 8.65185"	**Easting:**	3204627.01
Ellipsoid Height:	-70.00	**Elevation(4):**	19.19
Convergence:	1ø 54' 34"	**Scale Factor:**	0.9998936479
Satellite Observable:	YES	**Elevation Factor:**	1.0000033603
NGS PID (if applic):	AW5532	**Combined Factor:**	0.9998970078

General Location

Market Street 1.4 miles northeast of Sheldon

To Reach Description

From I-10 and Sheldon Road Travel south on Sheldon Road 0.4 miles to Market Street, then northeast on Market Street 1.4 miles to park entrance;Monument is 170' southeast of the centerline of Market Street.

Notes:

1. This is NGS' new classification system. Range VI indicates that this position meets the 0.02m-0.05m Accuracy Standard for Horizontal Position, Ellipsoidal Height, and Orthometric Height (elevation) at the 95% confidence level (m=meters).
2. Horizontal Adjustment - This survey is constrained to the NGS Published Horizontal positions of the geodetic stations adjusted by NGS in 2001.
3. Vertical Adjustment - This survey is constrained to the NGS Published Elevation for Northeast 2250 CORS ARP adjusted by NGS in 2001 and as published in PID AJ6430. Epoch Date 1997.00.
4. The elevation shown equals the Ellipsoid Height minus Geoid Height (from GEOID99) plus a constant of 0.253 feet.

Station Recovery Data:

RECOVERY DATA FORM - submit to Harris County Permits Division

For more information on Project Standards go to TECHNICAL DATA REPORTS damages resulting from the use of the data.

HARRIS COUNTY FLOODPLAIN REFERENCE MARKS

Project Name:	Tropical Storm Allison Recovery Project	Floodplain RM No.:	070525
		Stream Number:	G103-01-00

Station Sketch:

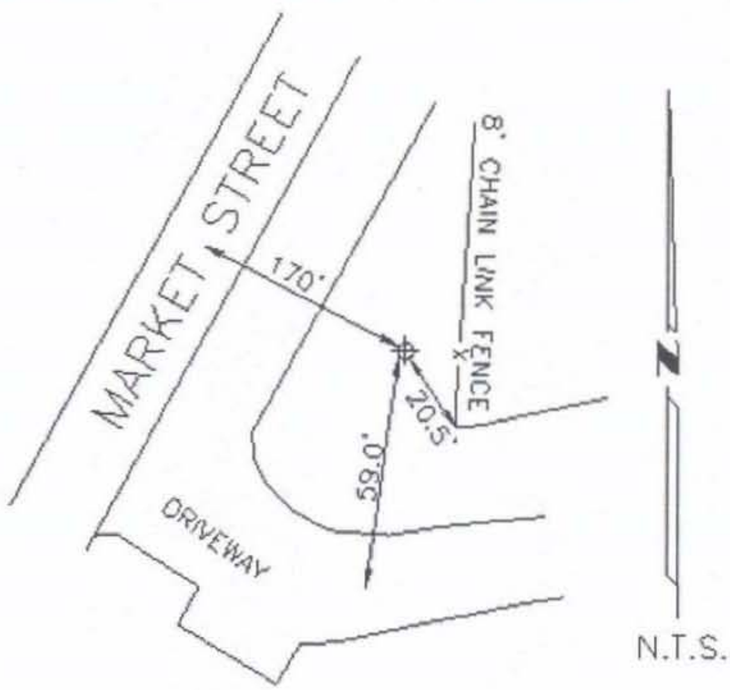


Photo 1-Station Detail:	Photo 2-Station Area Picture:

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